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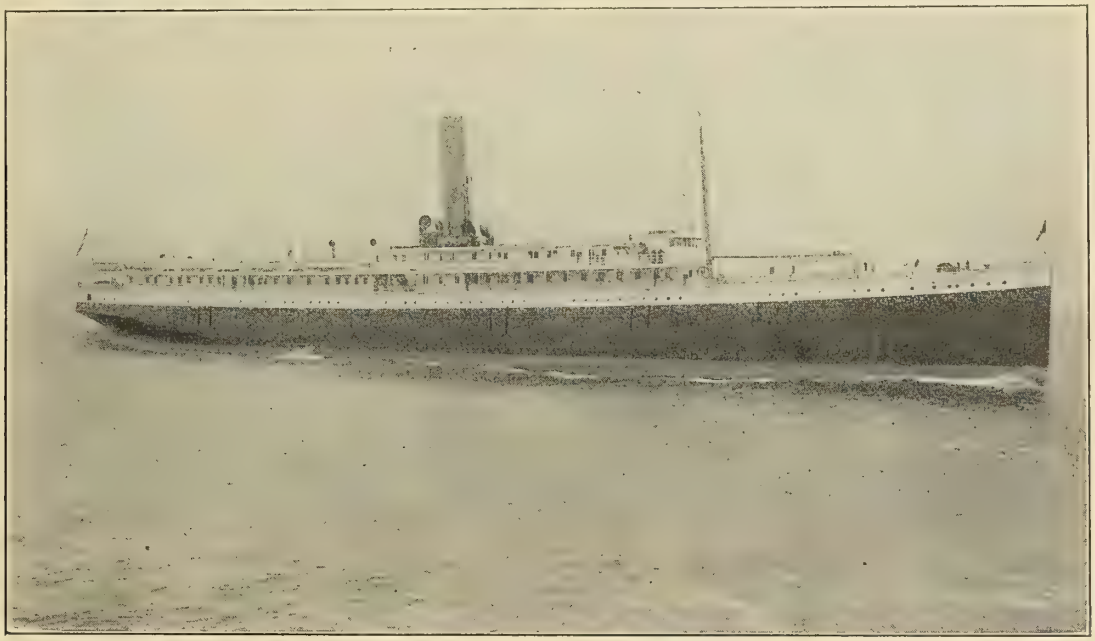
THE NEW STEAMSHIP MADISON OF THE OLD DOMINION STEAMSHIP COMPANY'S FLEET.

On January 31, the Newport News Shipbuilding & Dry Dock Company delivered from its works at Newport News, Va., to the Old Dominion Steamship Company the new steamship *Madison,* which was built for the latter company's daily passenger and freight service between New York and Norfolk, Va. In dimensions and general design the *Madison* is a duplicate of the *Jefferson, Hamilton* and *Princess Anne* of the same fleet, except that a few departures have been made where experience has indicated their advisability. The dimensions of the *Madison* are as follows:

Length over all	373 feet 7 inches.
Length on waterline	359 feet 4½ inches.
Beam, molded	42 feet.
Depth, molded, to hurricane deck	35 feet 6 inches.

The vessel, like others in the coastwise service, is of the hurricane deck type, and in general appearance is similar to the other vessels of the line, except that the shape of the stern is of the bay steamer type and not of the conventional ocean steamship type. This shape of stern was adopted by the owners as being better suited to their particular needs in docking at the terminals. It gives more deck space on the main deck for handling lines, and it also has the advantage of allowing the steam steering engine to be connected directly to the rudder stock.



NEW COASTWISE STEAMSHIP MADISON.

The vessel has a single bottom, three complete decks, and lower deck forward and aft of the machinery space. The entire hull is of steel, but the erections above the hurricane deck are of wood, these consisting of two tiers of deck houses and a shade deck extending from the stern well forward. The main and spar decks are completely plated, the former being a 17½-pound flush plated deck without wood covering, and the latter a 10-pound deck on which a wood deck is laid. The lower deck is laid with a calked wood deck except in the combustible storage space and over the fresh-water tank aft. The hurricane deck also has a calked deck forward of the over-all hatch, while aft of the latter there is a canvased deck. For the lower, main and spar decks the beams are of channel section, fitted generally on alternate frames. For the hurricane deck bulb angle beams are fitted on every frame in way of the calked deck, and wide-spaced angle beams with intermediate wood carlins are fitted in way of the canvased deck. Bulb angles are used for the transverse frames, and are spaced 24 inches centers throughout, extending from the center line to the main and hurricane decks alternately, except for a distance of 60 feet from the stem, where all frames extend to the hurricane deck. Reverse frames of angles are fitted across the top of the floors from bilge to bilge, and are doubled in the engine and boiler spaces. There is a flat plate keel, doubled throughout. The shell plating is fitted with raised and sunken strakes, with the heavy sheer strake located at the spar deck level, and the two strakes above of light scantlings. The vessel is subdivided by five watertight bulkheads.

The general arrangement of the *Madison* is well illustrated on the deck plans accompanying this article. From them it will be noted that there are passenger staterooms on the spar, hurri-

cane and shade decks, the total number of regular first class staterooms being seventy-six, each fitted with two berths. On the spar deck forward of the boiler casing further accommodations are provided for sixty-four first class passengers in thirty-one staterooms. These staterooms are fitted up exactly the same as the regular staterooms, but the bulkheads enclosing them are made in portable sections, as these rooms are only used during the season of heavy passenger traffic. At other times this entire structure is removed from the vessel and stowed on shore. This space then becomes available for freight, or it may be used for the transportation of deck passengers, 276 portable standee berths having been supplied for use therein; or it may be used for carrying horses, portable horse stalls having been provided. Forward of this space in a separate compartment accommodations are provided for sixty steerage passengers; the berths in this space are portable standee, so that when desired they may be removed and the space used for freight. Forward of the steerage space in two separate compartments are provided permanent berths for second class passengers, there being accommodations for twenty-seven men and twenty-four women. A cabin for second class passengers is provided in a separate house on the hurricane deck, with stairways to the sleeping quarters.

MAIN STAIRWAY STEAMSHIP MADISON.

Throughout the regular first class quarters all public spaces, passages, alcoves, etc., are finished in paneled mahogany, the latter wood being used exclusively for inside hardwood finish. In laying out the joiner work, consideration was given to the location of electric fixtures, radiators, etc., so that these fittings form an integral part of the design, the panels being arranged to suit. Special panels are fitted overhead in all the principal public spaces and in the captain's room. From the deck plans it will be noted that the main dining saloon is located on the spar deck, just aft of the engine casing, with a stairway at its after end leading up to the social hall on the hurricane deck. Directly aft of the dining saloon there is a lounging space, wherein are located a piano, bookcase, library table, etc. Abreast of this lounge there is a single row of staterooms on each side, three of the rooms having their interiors and ceilings paneled with composite board. Aft of the lounge, staterooms are fitted in double rows, and at the extreme after end there are the principal toilets, a bathroom, and a mahogany companion leading directly to the open hurricane deck. All staterooms on the spar deck, and those on the hurricane deck aft of the engine casing, have their doors opening from alcoves; the remaining staterooms have doors opening out on deck. An attractive feature in the upper saloon is a dome extending the full length of the saloon. The first class smoking room is located on the shade deck forward of the boiler casing, and forms a handsome apartment. It has a buffet attached, direct access to a toilet room and the wireless room, and has an inside stairway leading to a lobby on the hurricane deck. In the after end of the shade deck house there is located a dining room and also a smoking room for the use of colored passengers. In all the first class quarters and officers' rooms the exposed hardware is anti-corrosive, non-tarnishing white metal. The lavatories in all permanent rooms drain overboard. All first class toilets have mosaic tiled floors. Hard wood floors are laid in the smoking rooms, colored dining saloon, captain's room and officers' mess room. The decking in the first class dining room is finished bright.

In the line of cargo-carrying facilities the *Madison* is equipped with all that the extensive experience of the Old Dominion Steamship Company has found to be suitable for their particular requirements. As customary in the coastwise service, most of the freight is handled by trucks through cargo ports. Of the latter there are four on each side between the main and

spar decks and two on each side between the spar and hurricane decks, the main deck ports fitted with sliding watertight doors and the spar deck ports with hinged doors. Freight is also handled through an "over-all" hatch in the hurricane deck forward, by means of two derrick booms on the mast. In the main deck, which is the principal freight deck, there are six hatches, of which three are arranged in pairs and fitted with freight elevators, each of which is operated by a vertical double 7-inch by 7-inch engine. For use with the derrick booms there are located on the spar deck two dobule-cylinder reversible link-motion 8¼-inch by 10-inch hoisting engines, the latter being also used in connection with a cargo crane at the hatch on the deck below. There are in all seven cargo cranes at the different hatches on the main deck, for the operation of which there are three 6¼-inch by 8-inch double-cylinder winches. On the lower deck aft of the engine room a special compartment, from which all wood is eliminated, is provided for the carriage of combustible stores. This compartment is fitted up with smothering pipes and sprays, as required by the United States Steamboat Inspection Rules. Another compartment for combustible stores is provided on the spar deck aft.

In the line of hull machinery, aside from that already mentioned, there is a steam windlass driven by a 9-inch by 10-inch double-cylinder engine, the windlass located on the hurricane deck and the engine on the spar deck. A capstan on the hurricane deck is also driven from the windlass engine. On the spar deck aft there are also two capstans, driven by an 8-inch by 8-inch double-cylinder engine. For the steam steering gear there is a Williamson patent differential steam steering engine, 7 inches by 7 inches, direct connected to the rudder stock and operated from the pilot-house by a hydraulic telemotor, as well as from a steering stand on the shade deck aft. The electric plant, located on the spar deck abreast the engine room, consists of two 30-kilowatt direct-connected generating sets. In the equipment may be noted eight 24-foot lifeboats, stockless anchors, an 18-inch searchlight and a wireless telegraphy outfit. The "Rich" fire indicating and extinguishing system is also fitted.

The propelling machinery consists of a triple-expansion engine and four Scotch boilers, fitted with heated forced draft. The main engine has cylinders 26½ inches, 44 inches and 74 inches diameter, respectively, and 54 inches stroke. All cylinders have separate liners, and are fitted with piston valves, of which there are two on the low-pressure and one each on the other cylinders. The valves are worked by Marshall gear, and the direct-acting type of steam reversing gear is fitted. The condenser forms part of the engine framing, and an Edwards air pump and two bilge pumps are worked from the low-pressure crosshed. All other pumps are independent. A feed heater is fitted. The propeller is a solid four-bladed one of cast steel.

The four main boilers are located in a single compartment, with a fore and aft fire-room, and are connected to one stack. Each boiler is 14 feet 3 inches diameter by 12 feet 5 inches long; has three 44-inch corrugated furnaces with separate combustion chambers, and is allowed a working steam pressure of 190 pounds. The total heating surface is 9,428 square feet, and the grate surface 242 square feet. For the forced draft there are two 72-inch Sturtevant blowers with direct-connected 6½-inch and 11-inch by 6-inch compound engines. These blowers are located in the boiler casing at the spar deck level, and discharge through air-heating boxes, provided in the uptakes, to the different ash pits. Special air supply ducts are fitted for the blowers, and a suction is also provided from the cargo space, thus providing an exhaust system of ventilation for the latter. Bloomsburg feed-water circulators are fitted to the main boilers.

A donkey boiler of the locomotive type, 7 feet diameter by 12 feet long, built for 150 pounds steam pressure, is located on the main deck level between the engine and boiler casings.

The hull and machinery of the *Madison* were built under special survey of the American Bureau of Shipping, with their highest classification for vessels in the coastwise service. The vessel is designed to maintain an average sea speed of 15¾ knots in service.

ONE OF THE SALOONS.

TWIN-SCREW YACHT LIEN-CHING.

A twin-screw yacht has recently been built to the order of Prince Tsai Tsun, head of the Chinese Imperial Naval Board, by the Kiangnan Dock & Engineering Works at Shanghai, China. The order was placed on the eve of Prince Tsai Tsun's departure for Europe a year ago with the Naval Commission that visited Great Britain, France and Germany, returning via Siberia early this year.

The principal dimensions are as follows:

Length overall	173 feet
Length on waterline	150 feet
Breadth molded	25 feet
Depth to shade deck	20 feet
Draft, mean	9 feet
Displacement	500 tons

The yacht has a cut-water stem, elliptical stern, and is schooner rigged, with two pole masts. As she is a fast boat, her lines are very fine, and with her graceful shear she presents a very smart appearance. She has been built to meet the requirements of the Chinese Naval Board.

There are six watertight bulkheads, which, together with the bunker bulkheads, subdivide the vessel into eight compartments. To insure rapid handling, the deadwood has been cut away, enabling the vessel to make the complete turning circle, both engines full speed ahead, in a diameter equal to less than twice her own length. Provision is also made to receive six guns for saluting purposes. Bilge keels are fitted for about two-fifths of the length of the vessel amidships.

GENERAL ARRANGEMENT.

There are three decks—the lower, main and shade decks. The shade deck forms a splendid promenade for passengers, extending, as it does, all fore and aft, with little deck obstruction. The boats are of the navy pattern, with extra heavy davits to receive naval launches when required. The boats are fitted, permitting them to be chocked fully inboard, or along the extreme edge of the deck. There is also a searchlight platform fitted to the foremast. Amidships on the shade deck there is a composite deckhouse, which not only contains the entrance hall leading to the main reception room, with a grand staircase to the main deck, but which accommodates the navigating officer. The roof of this deckhouse forms a spacious flying bridge, upon which have been placed a chart cabinet, brass steering standard twin telegraphs and standard compass; the bridge being used exclusively for navigating purposes. An observation deckhouse has been fitted aft on the shade deck over the imperial reception rooms, with a private staircase leading to the saloon. The floors of the deckhouse on the shade deck are covered with interlocking rubber tiles of pale blue and white. The sides or walls of the deckhouse are paneled in polished mahogany, and the ceilings and beam moldings are in paneled pine, painted a dull white with edging of gold.

Below on the main deck is a large steel deckhouse given over to the exclusive apartments for the Prince and containing his bedroom, bathroom and lavatory, his private reception room and saloon, pantry, secretary's room, servants' quarters, etc. The rooms are all arranged adjoining, giving easy access. The clerestory roof, with a dome skylight of beautiful design with stained glass, with the Prince's coat-of-arms, serves to aid the natural overhead light, besides having a decorative effect and affording ventilation to the whole deckhouse. The floor is covered with thick interlocking rubber of a pleasing shade of green, and to relieve the plain ground Chinese rugs of the rarest fabrics of very elaborate design are installed. The walls of the Prince's apartments are finished in paneled Japanese dark colored oak, in bold designs, with carved capitals of cherry blossoms. The ceiling is of paneled pine, inlaid with lincrusta of a pale green color. The upholstery is of a rich, warm red silk, with window and door curtains richly embroidered to match, the whole combination making a pleasing and artistic effect.

Forward and around the engine and boiler casing are officials', officers' and crew's galleys, also the officers' mess room and deck staterooms. The forward part of the 'tween decks, on the main deck, contains the entrance to the dinning saloon below; with ladies' and gentlemen's lavatories on the wings at the after end, with two double doors, giving access to the main reception room. The reception room extends from side to side of the vessel and has six bays, which permit of being converted into living rooms at short notice if desired. The lounges, of the high-backed and wide type, are upholstered, as already described. Gun and revolver racks are arranged at sides of the staircase to the dining saloon. Arranged forward of the reception room is a ladies' boudoir, neatly arranged with carved writing tables and revolving chairs, lounges with handsome tables, with ancient carvings and comfortable easy chairs of fine rattan work and upholstered in keeping with the other furniture. Immediately below this, on the lower deck, is situated the guests' dining saloon, arranged with three large tables and handsome revolving chairs, capable of seating over thirty people. This saloon is neatly paneled and finished in white and gold, with the usual elaborate capitals and carved cornice moldings. The feature of this saloon is the airy, light and neat appearance it presents, although situated on the lower deck. Abaft this saloon are two roomy four-berth cabins for use of official deputies, finished in mail boat fashion; forward, the pantry is arranged and fitted with all modern utensils, and a trapway is arranged from the pantry communicating with the cold chamber.

NEW STEAM YACHT BUILT IN CHINA.

On the lower deck aft are the cabins for officers and engineers, finished in pine and situated behind the engine room, with double staircases, thus insuring a current of air in the passages. The petty officers are berthed in teak bedsteads, and the sailors and firemen are berthed, naval fashion, in hammocks.

The fore-and-after peaks are arranged for water ballast, and the fresh-water tanks are placed in the hold and lower 'tween decks, having a capacity of 1,500 gallons. The sanitary tank is placed above on the shade deck over the casing.

The galleys are large and complete with all modern utensils. The sanitary fittings throughout the vessel are of the best make. Each compartment or stateroom has an outlet and inlet ventilator placed at opposite ends, and with over thirty

small portable ball socket fans distributed in the public rooms the foul air is exhausted.

MACHINERY.

The machinery consists of two sets of vertical triple expansion engines, 10 inches, 16½ inches and 26½ inches diameter, with a stroke of 18 inches, indicating about 900 horsepower. There are no pumps on the main engines of any kind, all cylinders are separate castings supported on steel-turned columns. The condenser is common to both engines, and is of steel plate, with the usual composition tubes and tube plates.

Main feed pumps in duplicate are of Weirs' latest type, with float tank and feed heater, the air and circulating pumps are independent of special design constructed by the builders. Tank, bilge and sanitary service pumps of the duplex type are fitted to suit the requirements.

The shafting is of Siemens-Martins' mild ingot steel, forged by the builders from ingots supplied by Messrs. Thos. Firth & Sons, Sheffield.

Two cylindrical multitubular Scotch boilers are installed, designed for a working pressure of 180 pounds per square inch, with Howden's system of forced draft on the closed ashpit system. The coal bunkers have a capacity of 130 tons.

The engine room telegraphs are of the Chadburn type and are fitted, in addition to the marine loud-type speaking tubes, with connections to various important stations.

The machinery for working the ship includes a combined steam and hand windlass made by the builders, and a steering engine fitted in the wheelhouse below the flying bridge, being also made by the builders. There is a complete installation of electric light. The power plant is capable of generating and supplying light equal to about 6,200 candle power, and for all signal lamps, fans, etc.

On trial the vessel made a mean speed of 13.597 knots with natural draft, and 14.26 knots with forced draft. During the trials the weather was unsettled, as a typhoon was in the vicinity and a strong wind was blowing, which considerably retarded the speed.

ENGLISH SHALLOW-DRAFT AMAZON STEAMERS

BY FRANK C. PERKINS.

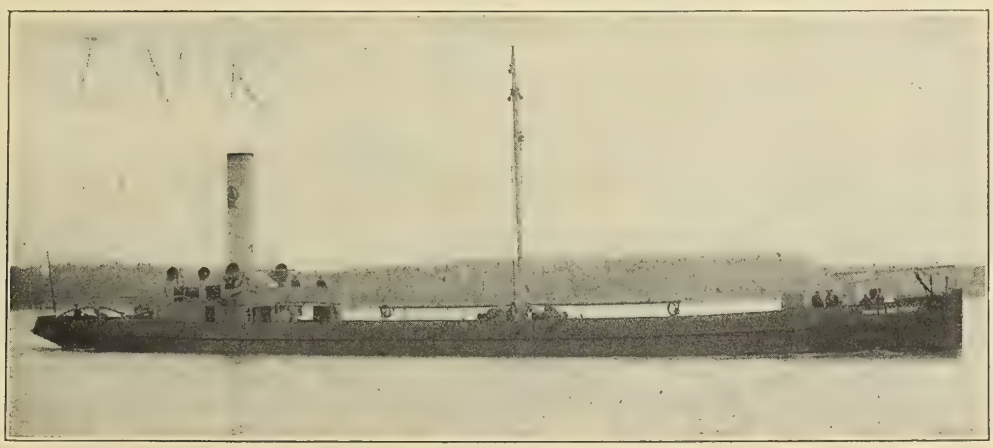
Figs. 1 and 2 show the design of the steamer *Paso de San Lorenzo,* and its deck equipment as it sailed from Southampton recently. It is one of five vessels of somewhat unique feature, built for the Amazon trade.

These new South American shallow draft boats are destined to open up the interior of Argentina—particularly the rich region through which flow the Parana, Uruguay and Paraguay rivers. The resources of this country have been but feebly tapped hitherto, and it is the culmination of the general desire of influential Argentinas that the benefits should be reaped by their own country, which has seen the formation of the company Marina Mercante Argentina, for whom the vessels have been built.

It is stated that these five steamers have a very large carrying capacity on small draft, a load of not less than 730 tons being provided for on a draft of only 8 feet. The dimen-

DECK OF THE PASO DE SAN LORENZO.

sions of the *Paso de San Lorenzo* are 220 feet length by 33 feet breadth, with a displacement of about 1,200 tons. The machinery comprises two sets of inverted triple-expansion surface condensing Thornycroft type engines, steam being supplied by two marine type return tube boilers. It is said that a speed of 10 knots mean is guaranteed, but this was exceeded very considerably on the official trials. The first boat actually ran at 11¼ knots as a mean of six runs on the Admiralty course at Stokes Bay, carrying the full load of 730 tons. The hull is built throughout of Siemens-Martin steel, and several powerful winches are installed on each ship, to facilitate handling the cargo, which, being timber principally, has had to be provided for by specially large cargo hatches. An electric lighting plant has been provided, and it is stated that the other



AMAZON RIVER STEAMER PASO DE SAN LORENZO.

arrangements are such that the boats are particularly adapted for working in the very hot climates to be met with in the northern portions of the rivers.

It is understood that the first few vessels have steamed out to Buenos Aires without incident, though an exceedingly rough passage was made by the *Paso de Obligale* from Southampton to St. Vincent. Nevertheless, the whole journey occupied thirty-four days, the coal consumed being 40 tons less than was anticipated, and working out at the very economical figure of 1.87 pounds per indicated horsepower. The subsequent vessels, with more favorable weather, have reduced the time for the journey by several days.

SOME RECENT MISHAPS TO VESSELS.

The steamer *Northwestern,* of the Alaska Steamship Company's fleet, ran ashore in False Bay, San Juan Island, at 2:40 A. M., Dec. 2, while bound from Seattle for Cordova. She took the ground at full speed, bringing up finally with her stem against the cliffs, twisting up her shell plating and breaking the stem bar. Her draft stranding was 19 feet 5 inches aft and 14 feet forward. At high water she lay aground for 50 feet forward, from which point the water gradually deepened to 8 feet under her heel, which took the ground at low water. Forward she was full of water, in the forepeak and No. 1 hold; the after-hold and engine and boiler rooms were dry.

The steamer struck on a shore fringed with rocks, extending shoal for 50 feet seaward. The water deepened rapidly to 30 feet at the stern and to 40 fathoms a cable off. The fractured plating, floors, frames and stembar lay hooked over several boulders forward. The stembar was broken and bent to the 15-foot mark, about twenty shell plates were crumpled, a portion of the keel bar gone, and several hold pillars and orlop deck beams bent. The after portion was apparently intact with the exception of the cross-section between the forehold and fire-room, which was slightly weeping. The diver's report showed a rocky bottom extending 50 feet from the cliffs, outside of which was a shingle bottom, sloping away on a 5 or 6 percent grade from a point 50 feet aft of the stem. From the stem aft for 50 feet the entire bottom was badly fractured and the keel bar gone, but after this the shell plating, stern frame, propeller and rudder were found undamaged. As her position was exposed to the strong winter storms which prevail from the south it required quick and effective work to save her from being broken up.

Salvage operations were conducted under the supervision of Capt. W. H. Logan, special agent for the Salvage Association of London, and Capt. S. B. Gibbs, representing the San Francisco Board of Underwriters. The contract for the work was let to the British Columbia Salvage Company. The salvors determined to build a platform or cofferdam to cover the damaged stem completely, and to make it of sufficient strength to take the vessel to Seattle for repairs, a distance of approximately 70 miles. The construction of this cofferdam was carried on simultaneously with the installation of three 10-inch pumps in the forward hold, the discharge of cargo and the transfer of coal to the after end. By Dec. 8 all the cargo, about 350 tons, had been discharged on lighters, dry and in good condition. Part of the general plan was to lay out astern a 4-ton anchor three points on the starboard quarter, with 120 fathoms of 5-inch wire hawser. By the time the cargo was discharged the cofferdam was completed, and about 150 tons of

WHAT HAPPENED TO THE NORTHWESTERN.

PRINCESS MAY BEFORE SHE WAS SALVED.

coal transferred from the side bunkers to the extreme after end of the 'tween decks.

This work was carried on only with extreme difficulty. Strong winds from the southeast set up a short swell, and in addition the ship's stern was rising and falling with the tide, causing her damaged stem to work up and down over the huge boulders, altering her shape and hindering the workmen at the bow.

The first effort to float the *Northwestern,* Dec. 8, was unsuccessful, and it was demonstrated that she bore too heavily on the rocks forward. This initial attempt to take her off was made by taking a heavy strain on the stern cables, with the tug *William Joliffe* towing and the *Northwestern's* main engines steaming full speed astern.

The next plan adopted was to put the vessel down by the stern and to continue lightering her forward. No heavy weights were left aboard, so 150 tons of gravel were ordered, while coal, estimated at 150 tons, was jettisoned from the forward bunkers. When this coal was out a second attempt to float was made at high tide Dec. 9, but again it proved a failure, as she was still bearing too heavily on the rocks. Jettisoning of coal was continued and the gravel was taken aboard. After careful consideration it was decided to flood the afterhold, and this was done with about 200 tons. The salvors were aware that it perhaps meant success or failure to get the vessel off Dec. 10, as the tides were taking off rapidly and the spring tides would not take place for eight or ten days later. During the interim the *Northwestern* would be in constant danger of being battered to pieces in a storm.

For these reasons supreme efforts were exerted Dec. 10, and they proved successful. The lifesaving tug *Snohomish* had a hawser to the steamer's stern and the tug *William Joliffe* was alongside. A strain was taken on the *Northwestern's* stern cables, and she drew clear of the rocks by the purchase exerted on her own anchors. The *Joliffe* held her one length astern until all moorings were clear, when she started under her own steam for Seattle, convoyed by the tug. This passage was made at slow speed, as it was feared the great strain to which the cofferdam had been subjected might have severely tested its strength. However, the *Northwestern* arrived safely at Seattle, exactly nine days after stranding. She was surveyed in Heffernan drydock, where the accompanying photograph was taken.

Capt. Logan has also achieved another success in the salvage of the Canadian-Pacific steamship *Princess May,* which went ashore on the north reef of Sentinel Island, Lynn Canal, on Aug. 5. Our photograph shows the difficult position in which this vessel was left by stranding. The photograph was taken at low tide, and at high tide the engine-room and dining saloon were completely filled with water. The stranding of the *Princess May* occurred while she was southbound from Skagway with eighty passengers and a crew of sixty-eight on board.

THE NEWPORT NEWS MISHAP.

No lives were lost and the vessel was successfully salved.

A very interesting illustration of the result of a collision of a wooden vessel is shown herewith. From it one is led to consider whether or not the light superstructure of river and harbor boats could not advantageously be bettered by the use of metal in its construction. The light nature of the woodwork is very noticeable, and the old comparison of "kindling wood" is certainly apt in this case. The three-cornered piece of the hull plating was not punched out, as at first sight might be supposed, but was ripped and crumpled up, as a little study of the illustration will show. The blow by the collision beginning at the forward end, the tearing of plating is indicative of considerable speed of the ramming vessel.

THE STRANDING OF THE CHATHAM.

The steamship *Chatham* made an effort to cross over the end of the north jetty in the St. John's River, Florida, with the result shown in the accompanying illustration.

RANDOM NOTES ON A LAKE FREIGHTER.

BY REAR-ADMIRAL CASPAR F. GOODRICH, U. S. N.*

Doubtless to many of my brother officers this brief article will seem like the proverbial bringing of coals to Newcastle, for they have lived upon the shores of the Great Lakes and have witnessed, if not the birth at least the development of its colossal shipping trade, but the rest of us have never enjoyed this great privilege and our notions, gained through casual report, must be, as my own were until recently, vague in the extreme. Having within the last few weeks enjoyed an opportunity of regarding this fresh-water system at close quarters, it would not appear out of place to lay before my fellows of the Naval Institute the fruits of my inquiries as embodied in notes made on the occasion.

Remembering the saying of the profane old English statesman, that there were lies, blank lies and statistics, I shall only remark that those who are in a position to know estimate the cargo tonnage which passed Detroit and the Sault Ste. Marie in the calendar year 1909, at seventy-two millions, more than three times as much as went through the Suez Canal, and more than twice as much as the total tonnage entered and cleared at the ports of Liverpool and London. Of this amount forty-two million tons were of iron ore brought from Lake Superior to ports on Lakes Michigan and Erie; and seventeen millions were of coal sent north. The balance was lumped under the head of general merchandise, or, as the local expression runs, "package freight." Surely such a vast movement justifies a few words touching the build of the ships that do the bulk of the work and the methods by which they are operated.

In the first place, it must be remembered that the season is ordinarily only eight months long. By the middle of December navigation is closed, to open again about the middle of April. It follows, then, that the most must be made of the period available, hence fairly good speed between ports and the briefest possible delay while at rest are imperative. These conditions having been frankly recognized, dominate the whole scheme. Confining my remarks to the transit of ore, I may point out the necessity at the one end of having that material in readiness on the ship's arrival and so stored as to be loaded into the hold with the utmost dispatch, and, at the other, of discharging it in the least possible time. It is of record that the *W. E. Corey* was, on one occasion, but an hour and a half at Two Harbors from the time of entering until leaving again, having in the meanwhile taken in some 10,500 tons, the exact loading time being thirty-nine minutes. This large cargo was taken out of her in four hours and a half. Such figures seem incredible until the appliances by which they are achieved are examined, when all becomes clear. The *Corey* made thirty-eight trips in one season and transported about four hundred thousand tons of ore.

In some ports a mammoth crane lifts an ore car from the railway tracks, swings it out over the vessel, capsizes it and shoots its 50 tons of ore down a hatch, but usually the ore is held in large bins 30 feet and more above the wharf. From these it is run down in steel chutes about 4 feet wide, semicircular in section, which are invariably 12 feet between centers, a constructional detail that, whether wise or unhappy, must be followed in the spacing of the vessel hatches. However long or short the steamer may be and however wide her hatches, as measured along her midship line, or however broad, measured athwartships, they are exactly 12 (or 24) feet apart from center to center, except where deckhouses intervene to make that distance an exact multiple of twelve.

The discharging apparatus is based on the clam-shell dredge, which is lowered into the hold to grab its charge, then elevated, swung back over the dock and emptied into gondola cars, or into carriers that convey the ore athwart the dock and dump it upon piles where is accumulated the winter's supply for the ravenous furnaces of Pittsburg, Cleveland and South Chicago. The latest shape this device has assumed is shown in the accompanying photograph. The long vertical member is kept vertical at all times by means of the movable levers, which, with the fixed upright, form a parallelogram. This arm carries the buckets, and can be raised or lowered at will. The buckets, moreover, are susceptible of turning in a horizontal plane about their vertical axis. Through these movements the buckets can rake up the ore in a nearly fore-and-aft line, form a heap and then gather up their huge charge of 15 tons at a hoist. The operator is stationed inside the vertical member at its lower extremity so that he descends with the buckets into the very hold of the ship for each load. Everything is done by electricity and so complete is the control that the buckets seem to be almost human as they search the corners of the ship and scrape the scattered ore together before seizing it in

THE J. PIERPONT MORGAN, ONE OF THE LARGEST LAKE CARRIERS.

* The United States Naval Institute Proceedings, No. 136.

their capacious maws. Locally these machines are called Huletts, after the inventor.

The vessels we are considering are simply floating, self-propelled ore tanks and, as a natural sequence, the entire length is devoted to ore carrying except enough at the stern to contain the boilers, engines and a portion of the crew with their accommodations, and at the bow, more quarters, the wheel house, steam windlass, etc. When looked upon as an adaptation to a specific purpose they are admirable. In their general appearance, the beautiful has been sacrificed to the useful, as this picture of the *J. Pierpont Morgan* will abundantly prove.

LOADING ORE BOATS AT LAKE SUPERIOR DOCKS.

The upper deck is flush from forcastle aft, broken only by the transverse hatches (in some cases thirty-six in number) fitted, in the later vessels, with steel covers that are not removed, but which, being telescopic, are simply pulled apart from the midship line by hook ropes taken to winches, the sections sliding over each other and occupying, when thus disposed, but little more room at the outboard end of the hatch than does one section alone. Stout tarpaulins and handy steel battens are always ready, as with us. During the summer they are seldom used, but he is a foolish captain who should fail to batten down securely, on leaving port during the late fall and early winter, for the lake gales come up suddenly and, at times, they are terrific in violence. The loss of certain freighters has been attributed to neglect of this particular precaution.

The engines are habitually triple expansion and the Scotch boiler is still the prevailing type. All lake freighters have but the single screw.

As a rule, the officers and crew are most comfortably quartered. Hammocks are unknown, berths being provided for all.

It is only in length that these vessels can be increased. The draft is inexorably limited by the depth of water at the shallow places between Lake Erie and Lake Superior to about 19 feet and 6 inches. The beam might be somewhat greater than the present maximum of 60 feet, the widest that can pass through the Weitzel (American) or the Canadian Lock at the Sault Ste. Marie,* were it not for the loading and unloading now based on a beam not exceeding 60 feet. To alter these would be so expensive an undertaking that we may believe the width of these ships as firmly fixed by man's own doing as is their draft by nature. These facts account for lengths which appear almost grotesque.

STEAMER LOADING AT SOUTH SHORE RAILWAY DOCKS, MARQUETTE, MICH.

*The Poe (American) lock has gates 100 feet wide.

Inside, the scheme of design is governed by the desire to make charging and discharging easy in the extreme. Thwartship bulkheads (except such as to divide the hold into separate watertight compartments) and stanchions are fast disappearing in favor of an arch construction which makes each hold an open box-like tank. The stresses on decks and keelsons, as the top and bottom members of the great fore-and-aft girder, must give the naval architects of the lakes much concern. Not being an expert in these matters I can only suggest that possibly the requisite strength in these respects is secured, in part, by carrying the double bottom well up on each side, and by making the spar-deck plates exceedingly heavy. These vessels survive the short seas on the lakes, but it is questionable whether they could ride in safety the longer waves of an ocean gale.

I noticed no trimming of the cargo, which is left in the comparatively low heaps formed by the dumping process. Experience has doubtless proved trimming to be unnecessary. Fortunately the material is heavy and not easily dislodged, else might a shift, when rolling deeply, prove fatal. The Marquette ores, being mined wet and full of jagged lumps, are thus presumably more stable than the earthy material quarried in the Mesaba region back of Duluth.

STEAMER J. P. MORGAN AT SUPERIOR DOCK, SHOWING UNLOADING MACHINES.

Most, if not all, of these freighters are provided with accommodations for a few passengers, since officials of the owning companies have occasionally to go in them on tours of inspection. During the summer months, a round trip from Lake Erie to Duluth or Two Harbors is extremely enjoyable and is coveted by many, both men and women, who possess, or think they possess, some claim on the owner or shipper. Hence, freighters though they be, they seldom go, at this season, without a full complement of guests. The quarters range from the bare comfort of a plainly furnished sleeping room and a seat at the table, where, often, all mess, except the firemen and deckhands, to handsomely equipped private suites and a separate dining room.

The personnel of the *Zenith City*, in which I was privileged to make the run to Marquette through the politeness of Mr. H. Coulby, the general manager of the Pittsburgh Steamship Company, comprised a captain whose salary may have been about $2,200 (£440) per annum, a first-mate at $130 (£27) per month; second-mate at $90 (£19), four wheelsmen and watchmen at $50 (£10); a steward at $90 (£19), an assistant at $36 (£7 4s.); a porter at $30 (£6); a chief-engineer at $175 (£35); one assistant at $125 (£25); one handy-man at $65 (£13); two oilers and four firemen at $52.50 (£10 10s.); six deck-hands at $31.50 (£6 6s.). This, by the way, is the usual complement. The steward is also the cook, and the food he prepares is the same for everybody, from the captain down. Excellent prog it is too—yet it is related that, on board one ship several years ago, before the introduction of "the open shop" and the defeat of the seamen's labor union, the firemen struck because the potatoes were not mashed. The passengers, in this case, happened to be a husky lot, who pitched in, shoveled coal and so brought the vessel into port.

Punishment is by fines, as it should be.

The men ship for the month, or for the round trip, and are paid by checks signed by the captain. As we have too often found among our recruits in the navy, there seems to be a lack of respect for the obligations of the contract of enlistment on the part of these freighters' crews, who make no bones of enlisting in ports of the lower lakes for the purpose of securing a free passage to Duluth and Two Harbors, where they desert at pleasure and take trains for the wheat fields of the Northwest during the harvest season, when wages are exceptionally high. This remark applies particularly to the deck-hands, whose work is almost *nil* while underway (they stand no night watch), and who are only really busy when in port, attending to the lines for moving the ship from empty bins to full ones or performing other services connected with the operations of loading and unloading.

It may be observed, by the way, that the absence of tide frees moving alongside the wharf from some of the inconveniences experienced in salt water and that frequent bitts on the dock stringer, together with steel lines, with permanent eye splices at the ends, worked from steam winches on the spar deck, reduce this maneuver to its simplest terms—tossing the end ashore, throwing it over a bitt and heaving in. The winches are four in number, two just abaft the Texas deck and two just forward of the after deck-house; two facing to port and two to starboard.

The language of the sea has suffered material modifications in its translation from the ocean to the lakes. For example: "Aye, aye, sir" has given way to "All right," "Ease your helm" to "Slowly," not to mention others equally significant.

Boatswains and their whistles are unknown. Men are called to meals by the "porter" or "assistant steward," who passes along the deck ringing a hand bell. This seems to be quite as effective as the cheery "pipe to dinner" of our service.

Some of the larger companies (the Pittsburgh Company reckons twenty-two barges and seventy-eight steamers in its

fleet) are gradually introducing customs similar to those on ocean-going craft, such as striking the half-hours on the ship's bell and restricting promotion to men and officers in their own employ. The Cleveland-Cliff Company forbids the latter to appear on shore while attached to a ship in port, except in its prescribed uniform. That an improved *esprit de corps* will be effected by such measures admits of no doubt.

The helpless barge, towed by a collier, is passing out of existence. While an economical method of conveying freight in bulk, as the practice on our Atlantic seaboard abundantly proves, the annoyances attending locking through the Soo and getting alongside of dock, together with the risk of disaster in heavy storms when the freighter's power is barely sufficient for her own needs, have acted as discouragements. It cannot say whether the employment of stout, seaworthy tugs has ever been the subject of practical trial. Doubtless this has been thoroughly studied, or these barges, some of which carry eight thousand tons of ore, would not now be in process of abandonment.

As may be imagined, the storage of provisions and of potable water gives little concern, since the trips are but three or four days in length between terminals and the navigation is in fresh water.

The speed and all distances are measured in statute miles. About eleven miles an hour empty and ten miles when full seem the average.

The engines rarely develop over two thousand horse, which in heavy gales, when the ship is light and largely the sport of the winds, must cause some uneasiness. The latter inconvenience is neutralized by letting water into the double bottoms. The jet condenser is universal. Despite the poor vacuum it yields (say 22 to 24 inches), these vessels are very economical in fuel. The *Peter White,* with 1,560 horsepower, for example, gets one horsepower for 1.7 pounds of coal, and she burns but 270 tons during the round trip of six days, yet she carries 9,000 tons of ore. The *J. E. Upson,* of the same capacity, on the same coal expenditure, develops 1.950 indicated horsepower, and makes 12 miles an hour when light.

There are numerous instances of coal consumption of 1.6 per horsepower and even less.

An automatic feed replaces the water tender.

Electric lighting is the rule.

Naturally, external corrosion of the hull and fouling, the banes of our existence, are unknown. The interior of the vessel is either red leaded, as with us, or is coated with a special black mineral oil, which has proved both cheap and effective.

The steering engine is commonly placed under the wheel. It is, however, also found in the engine room—a better location, of course. I heard some complaint of the telemotor by which this engine is controlled from the pilot-house, and I gathered the impression that captains, as a rule, prefer to have the steering engine directly under their feet.

The handling of these long craft gave me a favorable impression of the skill of their captains. A tug was used at Ashtabula in getting clear of the dock and out into the open lake, but neither the captain nor I thought this assistance necessary on that occasion, however valuable when the wind is blowing fresh. At Marquette we ran alongside the wharf as easily as possible and tied up at once. I could have wished more difficult conditions in order to observe better the captain's dexterity, although I have no doubt of his successfully meeting any requirements.

Of navigation, properly speaking, there is no trace on the lakes, for land is in sight the greater part of the time, and determining the ship's position by astronomical methods is quite unknown. The nearest approach is in ascertaining the compass error by the sun's shadow, his true azimuth being taken from tables. On the other hand, coasting and piloting obtain. In the former operation I did not notice the strict keeping of the run, as is customary with us, and the plotting of the ship's place on the chart, from time to time, by means of cross bearings, bow and beam bearings and the like. Probably this precaution is thought unnecessary, so frequently do the captains pass over the same ground. That a risk is incurred by not following our deep-water practice I am disposed to believe. The time is always recorded in the log when certain well-known headlands, etc., are abeam, together with the reading of the engine revolution counter dial. The log book is most simply kept. It contains but the barest story of the run. There are no divisions into watches, and several days' proceedings may appear on one page. The columns are marked as follows, viz.: Date, time, place to place, distance off, time from last place, upper compass, lower compass, on the left-hand page; wind weather, revolutions last six hours, revolutions, place to place, remarks, on the other. Temperature and barometer heights are absent and the remarks column is mainly a blank.

In piloting these captains are at their best. So far as my observation went they are masters of this art. Much has been done by the Lighthouse Board to make the passages over difficult points absolutely safe; lighthouses, beacons and buoys abound. In narrow places the channel is marked by buoys on either hand, which are lighted at night. It is only a question of keeping between them. Indeed, once entered there seems to be no more difficulty in getting through than of walking down Fifth Avenue. Then, too, under the River and Harbor Acts the government has already spent some fifty millions of dollars (ten million pounds) in removing obstacles, building locks at the Soo and in cutting long straight channels miles long, sometimes through dry land, to replace the tortuous navigation previously encountered. Again, these artificial waterways are, not infrequently, two in number, that vessels may not meet in narrow waters—a double-tracked road, so to speak. In addition to the buoys, they are provided with range targets and lights, leading when in line directly down the axis of the channel and furnishing incidentally a rigidly exact method of finding the compass error on that particular heading. A convenient blank book suitably ruled is in use by these captains for entering the observed headings by the standard and steering compasses at no less than sixteen such localities on the Detroit and the St. Clavis Rivers and twenty-one on the St. Mary's River between Lakes Huron and Superior. There can be no excuse for ignorance of the local deviation. Verbal communication between the pilothouse and engine room is usually by telephone. Signals to the latter are most frequently by the ordinary engine-room telegraph, now gradually replacing the small steam whistle once exclusively used. The latter is still retained for cases of breakdown in the telegraph.

A stout trolley wire, carrying a boatswain's chair, is stretched between the bridge and after deckhouse. Its value when the spar deck is swept by a heavy sea needs no explanation. This appliance is obligatory. Its need was made clear (in 1905) when a certain steamer, the *Mataafa,* of the Pittsburgh Steamship Company's fleet, having run ashore in a violent storm, all her crew stationed aft were lost through inability to reach the bow, for there is no passage-way between the ends of the vessel below the upper deck.

Speaking of weather, the late fall and early winter are apt to exact a heavy toll, especially on Lake Superior, with its rock-bound coast, lack of sea room and paucity of refuge harbors. In some seasons the wrecking of steamers and destruction of life are almost appalling. I am confident that some of this is needless, that it might be avoided if captains realized the possibilities which reside in good ground tackle skilfully managed. While very deep, say two hundred fathoms in parts, Lake Superior has a clay bottom with a gradual

slope towards the shores. Remembering what anchors did for our blockading fleet, were I caught in a menacing Lake Superior gale, I would shackle both chains to one anchor, and lower the latter down to extreme scope—about 180 fathoms. It would first act as a drag to keep the bow towards the sea, then it would touch the bottom with increased efficiency, finally it would catch in this best of holding ground and eventually bring the ship up long before she struck the reefs. The captains with whom I discussed this matter thought well of the proposition (for the originality of which I disclaimed any credit) and said they would adopt it on the first opportunity. One, Captain Murphy, of the *Peter White,* stated that he had tried it once, but a defective link parted and he was obliged to battle for safety with his engines alone.

Locking through the "Soo" is an interesting operation and performed with great despatch. Two locks are in use on the American side and one on the Canadian. There are no charges. A third and still larger lock is building by our army engineers. The difference in level between Huron and Superior makes a lock imperatively necessary. Doubtless the fact that the lakes' people are accustomed to this unavoidable process accounts for their general approbation of locks at Panama, a feature in our trans-isthmian canal as unnecessary as it is deplorable.

The return to Lake Erie I made on board the *J. E. Upson,* Captain J. G. Wood, through the politeness of Captain Wm. Morton, manager of the Wilson Transit Company of Cleveland. The steamer herself is among the larger of her kind, but not among the largest, having thirty hatches, while the maximum is thirty-six. She is, therefore, 72 feet shorter than the *J. Pierpont Morgan.* I found her captain alert and competent, as well as a thoughtful host, and her accommodations almost luxurious.

Speaking in general terms, I should say that the lake captains are quite as skillful in their more restricted employment as our battleship captains are in theirs, which embraces so much larger variety of incidents. Greater praise could not be given. From among the number of these fresh-water sailors excellent men can be drawn to help us out in time of war, for their intelligence is of a high order and they can quickly learn what is not, at present, of their experience.

Some surprise I felt in the absence of turbine engines in these freighters. Doubtless these may arrive some day provided the screws do not project so far from the midship line as to embarrass the operation of getting alongside the docks.

Nor has oil burning been attempted in spite of the proximity of the heavy oil field of Lima and of the advantage of eliminating the fireman, just now well in hand, but liable at any moment to prove, as of old, the source of infinite trouble.

The charts in use, while accurate, presented one feature which is not free from danger. The courses from place to place, as marked, appeared to me, in some instances, to shave the headlands or outlying reefs altogether too closely. In clear weather this is no drawback, but in fogs or thick weather a slight deviation from the correct magnetic heading might run a vessel ashore. It may be argued that a captain ought to disregard the chart course under such circumstances and give the next obstacle a wider berth than a mile and a half. Quite true; but a safer plan, according to my view, is to prescribe a course which will carry the vessel in good water at all times and yet leave a comfortable margin for error, for, being given on a government publication, it is naturally followed by the captain, who looks upon it as official.

It is hoped that my random notes may be found readable, if not profitable, by my colleagues of the naval service. In these days of marvelous and rapid development one never knows when some little scrap of apparently unrelated information may "come in mighty handy."

STABILITY OF MERCHANT VESSELS.

It sometimes happens that a vessel which is tender at the completion of her loading in the river is observed to become still more so when she reaches the open sea, although no weights have been moved on board. It is a little difficult for the non-technical mind to grasp the statement that this rather mysterious happening is the result of the vessel having in sea water, say, 5 or 6 inches less draft than in fresh, owing to the greater density of the former. It is usual to consider that increase of freeboard will lead to increase of stability, and in general it does so, but only at considerable inclinations from the upright position. In the neighborhood of the upright, if the vessel is of the usual merchant type and approximately at load draft, and if there has been no accompanying fall in the center of gravity, the stability will be decreased.

The change in a vessel's condition, however, due to the passage from fresh to salt water, cannot be great, and in most cases would probably be unnoticed. But during a voyage, and particularly towards its close, a vessel of small stability to begin with might evince unmistakable and even alarming symptoms of instability, although there might have been no change in the disposition of weights beyond that due to the consumption of the bunker coal, to which cause the new state of things must therefore be ascribed.

The burning out of the bunkers might affect the stability adversely in two ways:

1st. By causing a rise in the position of the center of gravity.

2d. By causing a fall in the position of the transverse metacenter.

The first would happen if lower bunkers alone were consumed and no adequate trimming were done; and the second if the vessel were of normal merchant type, and, at the start of voyage, were at full load draft. Thus such a vessel, although with considerably more freeboard at the start, might not only be in worse case as regards stability, but might even be in iminent danger of actually capsizing. It is probable that many losses at sea, otherwise mysterious, might be ascribed to this cause. It seems to the writer that too much light cannot be shed on this subject, and, in particular, that shipmasters in command of vessels which have special features in regard to stability should have these carefully explained to them.

Most commanding officers are aware of the danger there may be in consuming only lower coal, and make arrangements by which upper bunkers are trimmed into the lower as these become depleted; or if this cannot be done, use upper coal simultaneously with lower. Not many, however, are probably aware of the effect of reduction in the draft in the neighborhood of the load line, although in certain cases this alone might be sufficient to produce instability.

It has occurred to the writer that if a simple formula could be evolved, based on the general dimensions of a vessel, giving approximately the minimum height of the transverse metacenter and the corresponding draft, it should prove useful. This has led him to make the following investigation:

The general formula given in text books for the height of the transverse metacenter above the center of buoyancy is

$$B\,M = \frac{I}{V}.$$

I being the moment of inertia of the plane of flotation about its middle line as axis, and V the volume of displacement in cubic feet.

For prismatic bodies the value of $B\,M$ is quickly arrived at, but in the case of those of ship shape, the finding of both I and V being somewhat laborious, this is not so. In the latter case the general expression for I is

$$I = \frac{2}{3}\int y^3\,dx$$

and for V

$$V = 2\int\int y\,dx\,dz$$

z being any half ordinate of the load water plane, in the first instance, and of any plane in the second. Ship curves being irregular, integration is effected by means of Simpson's or Tchebycheff's Rules, and results are obtained by which accurate diagrams of metacenters may be drawn.

Besides the foregoing, most text books give approximate formulæ for determining the position of the metacenter, which, for our present purpose, it is convenient to recapitulate. In such expressions for the moment of inertia of the water plane

$$I = L \times B^3 \times C_1,$$

and for the volume of displacement

$$V = L \times B \times h \times C_2,$$

L, B and h being the length, breadth and draft of a vessel, and C_1 and C_2 coefficients depending on the immersed form. Using these approximations the expression for the height of metacenter above the center of buoyancy becomes

$$B\,M = \frac{L \times B^3 \times C_1}{L \times B \times h \times C_2} = \frac{B^2}{h}\,C_3$$

If we call the height of metacenter above the base line y, and that of the center of buoyancy above the same line d,

$$y = B\,M + d.$$

Now, d may be expressed in terms of the draft h, say

$$d = k\,h,$$

k being constant for vessels of similar form. Thus we may write, substituting the value found for $B\,M$,

$$y = \frac{B^2}{h}\,C_3 + k\,h \qquad (1)$$

Now differentiate the expression for z twice with regard to h. We have

$$\frac{dy}{dh} = -\frac{B^2}{h^2}\,C_3 + k \qquad (2)$$

and

$$\frac{d^2y}{dh^2} = +\frac{B^2}{h^2}\,C_3 \qquad (3)$$

Since (3) is positive, the value of h, which makes $\frac{dy}{dh} = o$, will, when substituted in (1), give a minimum value of z.

From (2) we get

$$h_m = B\sqrt{\frac{C_3}{k}} \qquad (4)$$

and from (1) by substitution,

$$y_m = \frac{B^2 C_3}{B\sqrt{\frac{C_3}{k}}} + k\,B\sqrt{\frac{C_3}{k}} = 2\,B\,\sqrt{k\,C_3} \qquad (5)$$

the suffix m being added to h and z to indicate that they refer to a minimum height of metacenter. Thus we have arrived at two simple formulæ giving the information desired.

Ref° Nos.	Block Coefficients at Load Drafts
1	1.000
2	.796
3	.783
4	.758
5	.633

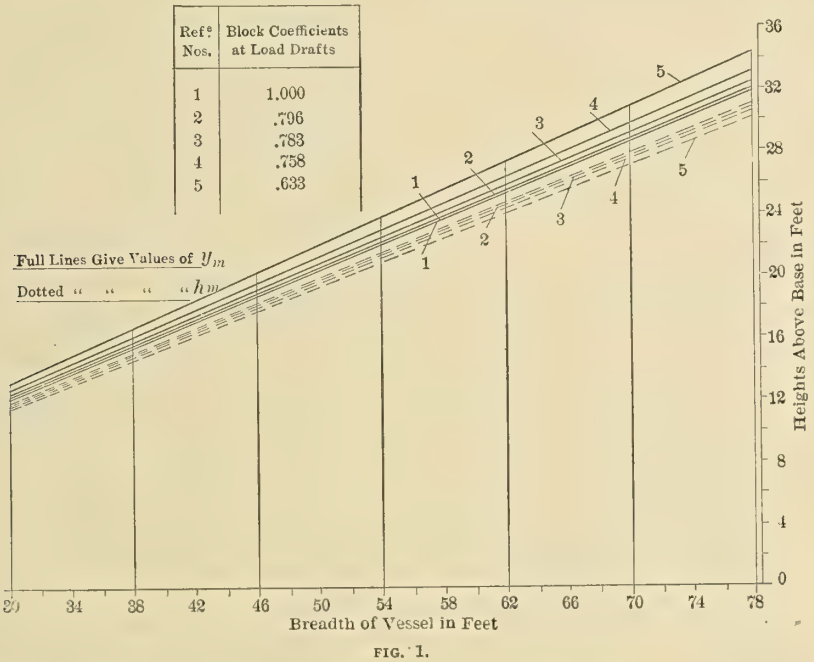


FIG. 1.

Let us apply the above to two typical cases, say, to a box-shaped vessel, which may be looked upon as the limit of the full-cargo vessel, and to a passenger steamer of fairly fine form. The case of most vessels will lie between these. Taking the box vessel, we have $k = \frac{1}{2}$ and $C_3 = 1/12$, as may be readily verified, so that

$$y_m = 2\,B\,\sqrt{\tfrac{1}{2} \times 1/12} = \frac{B}{\sqrt{6}} = .408\,B.$$

In this special case it will be found, by substituting in (4), that

$$h_m = .408\,B;$$

that is, the metacenter is in the line of flotation. The explanation of this is found in the fact, as shown by (5), that when the height of the metacenter above the base is a minimum, it is just double that of the corresponding center of buoyancy, and that in a box-shaped vessel the center of buoyancy is at half draft.

In applying the formulæ to our second example, care must be taken in fixing the values of the coefficients, which, of course, must correspond to the draft at which the height of metacenter is a minimum. In the present case the block co-

efficient at load draft is .633, and the coefficient required for the formulæ are as follows:

$$C_1 = .048$$
$$C_2 = .570$$
$$\therefore C_3 = \frac{.048}{.570} = .0844$$
$$k = .568$$

Substituting in equation (4) and (5) we get

$$h_m = B\sqrt{\frac{.0844}{.568}} = .386\,B,$$

and

$$y_m = 2\,B\,\sqrt{.0844 \times .568} = .44\,B.$$

Since h_m and y_m are linear functions of B, they may be readily plotted, and this has suggested the making of the diagram indicated by Fig. 1. In this diagram values of h_m and y_m, corresponding to vessels of varying degrees of fineness and of any breadth within the limits of the figure, may be read off.

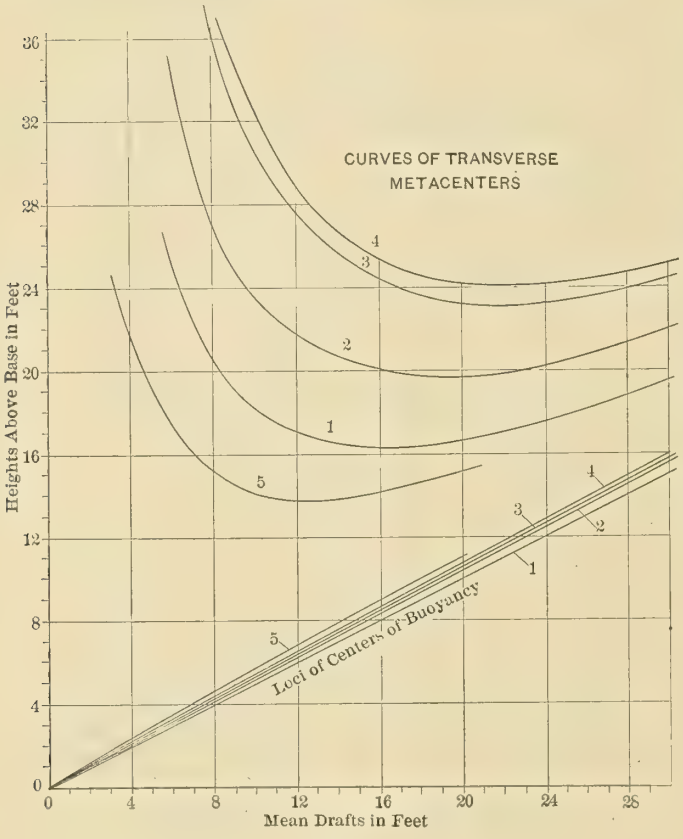


FIG. 2.

In the construction of Fig. 1 results of actual cases have been employed, and for vessels of exactly similar type the lines on the diagram are accurate. For vessels of similar type, but other degrees of fineness, a close approximation to the values of h_m and y_m may be found by interpolation.

Fig. 2 depicts the metacenter diagrams of the vessels employed in constructing Fig. 1, the particulars of these vessels being as follows:

No.	Description.	Length, Ft.	Breadth, Ft.	Ins.	Load Draft, Ft.	Ins.	Block Coefficient at Load Draft.
1.	Box vessel	...	40	0	.....		1.00
2.	Very full cargo steamer	330	48	0	22	0	.796
3.	Ordinary cargo steamer	469	56	0	27	3	.783
4.	Finer cargo steamer	500	57	3	28	9	.758
5.	Passenger steamer	230	31	4	14	0	.633

The general line for box-shaped vessels is shown in Fig. 1, but only for comparison. The difference between a box-shape and even the fullest vessel of normal type is so great as to make it unsafe to use its curve as a guide in predicting values for ship forms.

The diagram (Fig. 1) is an interesting exercise in the geometry of the metacenter, but it has also a practical value. In designing, for instance, it should prove useful in arranging the permanent bunkers. By means of it, the center of gravity having been approximated to, and assuming the draft with coal out to approach h_m, the minimum value of metacentric height, or $G\,M$, might be obtained. If this should be too small or negative, it might be advisable to rearrange the bunkers. It may be pointed out, of course, that with coal out, water ballast could be run in; but it is inadvisable to do this with the ship in motion at sea; and if it could be obviated by another arrangement of bunkers, the design of the vessel would thereby be improved.

Fig. 1 should also be useful to shipmasters who know something of stability, and, in particular, how to make a heeling experiment. After loading and bunkering, the position of the center of gravity might first be found experimentally. Then the extent to which it would be modified with the coal out could be readily estimated, bunkers being as a rule of simple shape. If the position of the center of gravity thus found, taken in association with the minimum height of M obtained from the diagram, showed the vessel to be dangerously tender, it would be advisable to rearrange some of the cargo, unless it were possible to so plan the burning of the coal—*e. g*, by using upper bunkers first—as to prevent a dangerous rise in the position of G while the vessel was actually at sea. In port, of course, water ballast could be run in to take up the draft and bring down the center of gravity.

It is perhaps scarcely necessary to point out that such a diagram as Fig. 1 is only of importance in the case of vessels whose metacenter curves have generally the characteristics of those in Fig. 2. In some cases the *locus* of metacenters is a horizontal line, or nearly so; in others—in vessels having immersed sections of peg-top form, for instance—it is actually concave to the base. For such special vessels a diagram like Fig. 1 obviously could not be constructed. Most modern merchant steamers, however, have metacenter curves like the kind we have been dealing with, and it is to them the foregoing remarks are intended to apply.

FLOATING DRY DOCKS IN THE UNITED STATES. RELATIVE VALUE OF WOOD AND STEEL FOR THEIR CONSTRUCTION.

BY WILLIAM T. DONNELLY.*

While the floating dry dock is not by any means new in the United States, and while it is generally admitted to be an American invention, the application of technical knowledge or the skill of the engineer has so recently been called upon for its design and construction, that the writer feels almost bound to offer some historic references.

The oldest available record is a copy of a patent to J. Adamson for floating dry docks, December 13, 1816. For a description of this and of subsequent types of wooden floating dry docks, which have been developed in the United States, the author refers to a paper read before the Brooklyn Engineers' Club under date of January 25, 1905; and for an excellent detailed description of large floating dry docks built for the United States Government prior to 1850, parties interested are referred to "Naval Dry Docks of the United States," by Charles B. Stuart, chief engineer of the United States navy. This is one of the most valuable works in existence, not only as regards floating dry docks but basin docks as well, giving such an excellent description of the construction and diffi-

* Read at the eighteenth meeting of the Society of Naval Architects and Marine Engineers.

culties overcome in the building of the first basin dry dock at the Brooklyn Navy Yard as would be appreciated by those who have had the later construction under their care.

For the most modern description and record, bringing the history of floating dry docks in this country up to the date of the completion of the steel floating dry dock *Dewey,* reference can be had to the book entitled "Floating Dry Docks," edited by Sven Anderson, M. E., superintendent Floating Dry Dock Department, Maryland Steel Company. This work is a careful compilation of recent papers delivered before the various engineering societies in this country.

Special reference should be made to very important papers by Civil Engineer A. C. Cunningham, U. S. N., and Civil Engineer Leonard M. Cox, U. S. N., the latter paper dealing with naval dry docks and being a most complete presentation of mathematical and structural problems. This paper will also be found in the Transactions of the American Society of Civil Engineers for 1907.

In 1906 the author was retained by a large dry-docking and ship-repair company to prepare plans for a floating dry dock. The general requirements were that the dock should ultimately have a lifting capacity of 20,000 tons and that approximately 12,000 tons lifting power was to be built at the beginning and added to later on.

While the author's experience had previously dealt with wood as a structural material for floating dry docks, he was also familiar with steel for such structures, and owing to the fact that all docks of approximately this size had been built of steel attention was directed to that material, and a careful study made resulted in the selection and design of the Rennie type of dock, with steel pontoons and wings, the pontoons being 14 feet deep, 28 feet long and 127 feet wide. The steel wings were to be 40 feet high to give ample longitudinal rigidity. The details of this dock were very carefully worked out so that accurate weights were arrived at. They were 6,600 tons for the pontoons and 2,700 tons for the wings, or a total of 10,300 tons for the structure, which, on a basis of 20,000 tons lifting power, gives as a factor of structural weight relative to lifting power, of 5 : 10, which agrees fairly well with other large docks previously designed and built.

The fact that a working stress of 12,000 pounds per square inch was used throughout, and that the wings of the Rennie type of dock were made of exceptional depth to insure longitudinal rigidity, will account for a somewhat higher weight factor.

While this dock was not built, bids which were received indicated that the cost of the dock completed would be approximately $57 (£11.7) per ton of lifting power. For a more complete description of this dock and the novel method of pumping by compressed air which it was intended to use, those interested are referred to a paper entitled "A New Method of Pumping Floating Dry Docks," read before the Brooklyn Engineers' Club on May 9, 1907. The reason for introducing the matter here is to effect a comparison between this structure and similar docks with wooden pontoons.

In a pontoon dock of 7,000 tons lifting capacity, with steel wings and wooden pontoons, the pontoons are 100 feet long, 11 feet deep and 32 feet wide. Each pontoon has eleven frames or trusses on 3-foot centers. Top and bottom planking is 4 inches, the side planking 5 inches and the end planking 6 inches; 6-inch by 8-inch deck timbers are worked across the 10-inch by 10-inch truss members on top and bottom in such a way that it is possible to get in the 1⅛-inch double tie-rods without boring, and so arranged that they can be replaced at any time.

The material is merchantable grade of yellow pine lumber throughout and the fastenings are all galvanized. There were required for each of these pontoons 135,000 board feet of lumber.

The steel wings of this dock are 368 feet long by 30 feet high, 12 feet wide at the bottom, and 8 feet wide at the top. The plating varies in thickness from one-quarter inch to one-half inch. The securing of the wings to the pontoons is accomplished by means of a cast steel shoe secured to the deck of the pontoon and connected by a link and taper wedge and similar shoe riveted to the side of the wing. On the outside of the dock, attachment to the pontoon is by a cast steel strap through-bolted to the side of the pontoon. This device is of exceedingly simple construction and has proved most effective.

A pontoon has been detached by knocking out the wedges in less than ten minutes. The remainder of the dock is then pumped up, when the detached pontoons can be floated out and dry-docked on the remaining pontoons. The total weight of steel work in the wings is 1,100 tons. Attention is called to the fact that all of this steel is normally above the waterline, where it is accessible at all times for examination and repair.

Contact between the wings and pontoons is made by a raised packing piece, 12 inches wide, surrounding the open top of the pontoons under the wings, it being understood that there is a hole in the bottom of the wing to allow free passage of water from the pontoon to the wing when the pontoon is full. The joint between the pontoon and wing is made with three-ply canvas packing, saturated with red lead, and the wing, at the point of contact, is reinforced with ⅜-inch by 12-inch steel plate to insure against possible corrosion, this being the only part of the wing, inside or out, which is not accessible when the dock is in commission.

The method of pumping is by a centrifugal pump in each end of each pontoon, all the pumps on one side being operated by a single electric motor through horizontal line shaft and vertical shaft to the pump. The delivery and entrance of water to the pontoon is through the pump, which has been found to be a very effective method of control. A more complete description of the construction and operation of this dock can be found in International Marine Engineering under date of August, 1909. While this dock is shown and referred to here as a 7,000-ton dock, with eleven pontoons and a length of 368 feet, it was actually built with ten pontoons and a length of 335 feet in the wings, this being the greatest length which would leave room for handling vessels in and out in its present location on the company's property. The additional pontoon is to be added and the wings extended when the plant is enlarged.

While wooden wings are not practical for the largest size of docks, they are applicable to docks up to 10,000 tons, and where used there is a bulkhead in the wings corresponding to each pontoon and that the construction of the wings may be interrupted at any point. In order to extend the dock, it is only necessary to build one or more pontoons, float them in position and extend the wings over them, which can be done without interrupting the use of the dock.

The machinery and pumping of this dock is similar to the one previously described.

COMPARISON OF WOOD AND STEEL FOR FLOATING DRY DOCKS AND METHODS FOR THEIR CARE AND PRESERVATION.

As previously stated, the building of timber floating dry docks in the United States is very old, and there are now in use in the Port of New York sixty-four floating dry docks, all of wood, ranging in tonnage from 400 to 12,000 tons, and in the United States there are ninety-one floating dry docks, three of steel and one with steel wings, ranging from 200 tons to 18,000 tons, having a total tonnage of 228,800 tons and an average tonnage of 2,500 tons.

The only steel commercial floating dry dock is at the works of the Great Lakes Shipbuilding Co., Detroit, Mich. The only

other steel floating dry docks in use in the United States are the Algiers dock opposite New Orleans, La., and the steel dock taken by the United States Government from Havana during the Spanish War, now in Pensacola, Fla. The Detroit dock and the Algiers dock are in fresh water, which makes their preservation much easier.

The Tietjen & Lang Dry Dock Company, of Hoboken, has nine floating dry docks, all of timber construction, varying in lifting capacity from 800 tons to 10,000 tons. Their first dock was built in 1884, and is still in satisfactory operating condition. No deterioration whatever has taken place in the timber work below water, but extensive repairs from time to time have been made in the upper woodwork, which, of course, will deteriorate equal to, or somewhat more rapidly than, ordinary woodwork of buildings.

The John N. Robins Company, Erie Basin, Brooklyn, N. Y., has two large floating dry docks other than the pontoon dock, with steel wings previously referred to. One of these docks, known as the balance dock, was built by William H. Webb and finished in October, 1854, and has been in continuous use ever since. The writer has recently had the opportunity of thoroughly examining and overhauling this dock and changing over the pumping plant from steam to electric operation. A most thorough examination of the interior and weight-supporting timbers showed practically no deterioration, not a particle of decayed wood being found below the deck. Certain corrections were made, due to faults in the original design, to obtain a more positive control of the dock in operation, and since the overhauling the dock has lifted fully as heavy ships at at any time in its history. Much of the upper woodwork of this dock has been replaced, and much more will have to be replaced from time to time.

Attention should be called to the fact that, owing to the size of this structure, 330 feet long by 100 feet wide, it has never been possible to entirely remove it from the water.

The other large floating dry dock of the John N. Robins Company is of the Dodge-Burgess type of sectional dock, having ten sections with pontoons 100 feet by 30 feet. The general construction of this dock can be seen by referring to the work by Stuart, entitled "Naval Dry Docks in the United States," previously referred to, where there will be found excellent descriptions with illustrations of similar docks built for the United States Government at Philadelphia and Portsmouth, N. H.

In protecting the wooden pontoons of floating dry docks and, in fact, all under-water parts of floating dry docks, it has been the universal custom to first thoroughly grave them with brown tar poisoned with arsenic, then apply two layers of best sheathing felt, thoroughly graving each layer in a similar way, and then over this to sheath the dock with 1-inch creosoted hemlock boards well secured with galvanized nails. This has been found entirely satisfactory to protect these docks from teredo and worms, and the custome in Eastern waters has been to leave them in the water for seven years before taking them out to replace any sheathing which may have become detached.

The largest floating dry dock on the Pacific Coast for many years was the Quartermaster's Dock in Puget Sound. This dock was built of timber in 1892, and while it has been exposed in what is considered to be very bad water for teredo since its construction, it was in excellent condition when examined by the writer last winter, although on account of its dimensions it has never been removed from the water.

At the time of the construction of the pontoon dock, with steel wings, a very thorough investigation was made as to the preservation of the steel wings by painting. This resulted in the use of a graphite paint of well-known manufacture. The cleaning and painting was done in the most thorough manner by day's labor under skilled direction, and when it was completed everyone expected the most satisfactory results. The outcome, however, was very disappointing. After two and a half years, the interior of the wings is now being coated with bitumastic composition and the outside will be painted with red lead and oil. None of the pontoons in the meantime have been removed from the water nor have they required attention in any manner.

All the writer's experience with floating dry docks and their construction and repair leads to the firm conclusion that for underwater work, such as pontoons for the Rennie type of dock, wood is a much superior material of construction to steel, that the original cost is much less, the cost of maintenance less, and the life of the structure greater than steel. For the wings and upper work, experience is equally conclusive for the use of steel. While it apparent that the cost of maintenance will be considerable, the structure will last much longer, and, with a sectional pontoon dock, where the wings are accessible at any time and any portion of the wings may be entirely replaced if necessary, it would seem that the structure as a whole will last indefinitely.

So far as the writer is able to judge by a somewhat limited experience, the only reliable protection for interior steel work of floating dry docks in salt water is the bitumastic compound above referred to, but the first cost of this protection is very great, being in the neighborhood of $6 (£1.2) per ton of steel for interior protection only. Any discussion which would bring to bear additional information upon this particular subject would be very much appreciated, and it is to be hoped that the experience of the United States Government with the floating dry dock *Dewey* at Manila will be of help.

A comparison of the materials used for wooden and steel pontoons shows that the weight of the steel per hundred tons of lifting power is 33 tons and the weight of wood per hundred tons of lifting power is 36 tons. It is evident that the difference in weight must be supplied by increased dimensions of the wooden pontoons. Other than in this particular, wood appears to have the advantage in every way.

While reference has been made to a pontoon dock of 7,000 tons lifting capacity, there does not seem to be any engineering limit to the size to which the Rennie type of dock can be built with wooden pontoons. A carefully worked-out pontoon for a 20,000-ton dock shows dimensions of 130 feet by 44 feet by 15 feet, and it will be readily understood that this structure is well within the practical limits for timber work.

Regarding the cost of the different types of floating dry docks, it is, of course, not possible to make any definite statements, as they are much influenced by the varying cost of material and the location where the dock is to be constructed. For the relative cost of the different types of docks on the eastern coast of the United States the following figures may be taken as being approximately correct:

COST PER TON OF LIFTING POWER.

	Per Ton.
Balance sectional timber dock with centrifugal pumps	$32 (£6.6)
All-wood pontoon dock with continuous wings	35 (£7.2)
Pontoon dock, steel wings and wooden pontoons	42 (£8.6)
All-steel pontoon dock	57 (£11.7)
Government steel dock, Dewey type	62 (£12.7)

The comparative cost for the western coast of the United States will be quite different on account of the increased cost of steel and the much lower cost of timber.

A Japanese Design of Surface Condenser.

At the last meeting of the Japanese Institution of Naval Architects, Captain-Constructor Y. Wadagaki gave a description of a surface condenser possessing some novel features, designed by himself, for an installation of two sets of 1,500 kilowatt generating units fitted at the Saseby Imperial Dockyard. The general design of the condenser is shown in Fig. 1. The exhaust inlet is at *A*, and the current of steam is directed

tangentially to the inner surface of the condenser shell, which is of a spiral cross section. This has the effect of separating by centrifugal action any water in the exhaust steam as it enters the condenser. Near the center of the tubes, and parallel to the axis of the condenser, is a large split pipe *B* between the tube plates, containing a group of cooling tubes. An annular space is thus formed between the split tube and the condenser shell, of volute form, fitted with ordinary condenser tubes, and open at its narrow end; hence any steam at the end of one turn round the nest of the condensing tubes is caught up by the entering current of exhaust steam and again carried round. By suitable adjustment of partition plates, the flow of water through the tubes is made to follow the course that theory and practice assign to be the best. Through the bottom of the condenser, near the exhaust-steam inlet, a short length of pipe protrudes; this allows a certain quantity of water to accumulate and expose its surface to the incoming exhaust steam, the surplus water being drained off through the pipe by a water-pump suction. The air-pump suction is connected with the large split pipe, into which the air flowing round is finally entrained. Captain Wadagaki claims that by his design all the energy due to velocity of the exhaust steam is profitably employed in maintaining brisk circulation of steam among the condensing

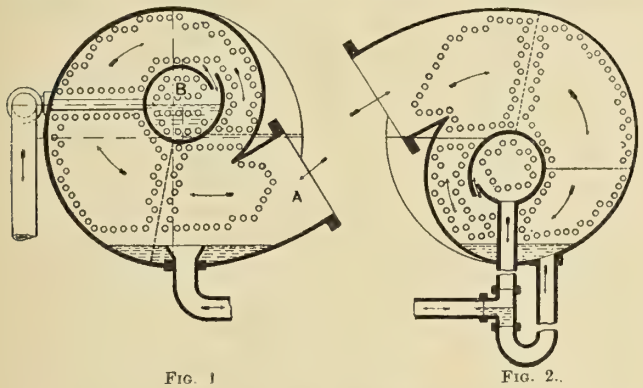


Fig. 1 Fig. 2.

A NEW TYPE OF CONDENSER.

tubes, and that this is effected without baffling plates or other obstructions, except such obstruction as the condensing tubes themselves must always furnish. Further, there is no short-circuit, dead-corner, or stagnant recess to detract from the efficiency of the cooling surface. Any water in the exhaust steam at the inlet is at once withdrawn, while water resulting from condensation of the steam within the condenser is separated from the surface of the tubes and promptly removed to the outside of the tube nest by virtue of its centrifugal force. This water ultimately flows to the bottom of the condenser along the inner surface of the shell, and comes again into direct contact with the entering exhaust, its final temperature being thus practically equal to it, whatever the quantity of circulating water supplied. The condenser, to a certain extent, therefore, becomes a feed-water heater. The work of the air-pump is further facilitated by the cooling of the air in the split pipe, where, by design of the water passages, the circulating water is the coldest.

In the arrangement above described there are two separate pumps—one for the air, the other to draw off the water of condensation. If a single pump is preferred, the design may be modified, as shown in Fig. 2, where the exhaust steam enters at the top, while a common suction is provided at the bottom for the water gathered there, and for the air collected in the split pipe, the necessary separation being provided by the U-bend shown in the diagram. Approximate figures are given by Captain Wadagaki in his paper of tests made at Sasebo, to show the high efficiency obtained with this condenser there installed.—*Vulcan.*

MARINE DIESEL MOTORS.

A paper on the above subject was read at the annual meeting of the German Naval Architects by Direktor Saiuberlich, of Osterholz-Scharmbeck, near Bremen. According to *The Engineer,* Direktor Saiuberlich said that since the times of the old low-pressure engine the shipping world had never stood on the threshold of such far-reaching developments as at the present time. In place of the steam engine, a further improvement of which appeared hardly possible, the Diesel motor was now being installed as a marine engine. For fluid fuel the Diesel motor was the most perfect internal combustion engine of the present day. In recent experiments the utilization of the fuel had reached 33 to 35 percent, as compared with 23 percent in the gas engine and 13 percent in the best steam-engine plant with superheater. This was a result of the direct use of the fuel in the cylinder without previous transformation, and of its consequent complete combustion. The construction of the Diesel motor was said to require material and workmanship of a very high class. These, however, were now-a-days obtainable, and the difficulties on this head formerly experienced were overcome. Like the larger type of gas engine the larger Diesel motor had very much the general appearance of the marine steam engine, on which it was more or less modeled. Now that several shipyards had shown that they could build the motors with the machinery already at their disposal, the prejudice against these engines would soon be overcome. Hitherto the motors had generally been of the single-acting description working on the four-cycle system. More recently the two-cycle engine had come to the front. The endeavors to apply the new system to the propulsion of large vessels had led to the application of double-acting motors of the two-cycle as well as of the four-cycle type. Such installations were now actually being made and would shortly be at work. The problem before the designer was to adapt the Diesel motor, that had worked satisfactorily on land, to the conditions on board a vessel, different in many respects and more difficult to meet, as these were. Moreover, the auxiliary machinery depended on the steam from the boilers, and a substitute for this had to be found. The advantages of the Diesel motor for the driving of vessels were the following: A gain in available space due to the removal of the boiler installation accompanying a reduction of that required for the new fuel; an increase in carrying capacity on account of the reduction in the weights of motive machinery and fuel; a possibility of using spaces formerly only partially available for the storing of the fuel; gains in time and wages due to easier and more rapid bunkering, coupled with the elimination of coal trimming; greater readiness for starting work; easier work for the engineers; abolition of stoking; greater cheapness of fuel; comparative coolness of he engine room; and greater radius of action for the vessel. Disadvantages were: The difficulty of obtaining fuel in many ports and the absence of steam for the deck machinery and for heating purposes. Herr Saiuberlich gave particulars of the first two Diesel motor vessels—the *Frerichs*, built for purposes of the shipyard, and the fishing vessel *Ewersand,* the engines for which, as well as the hulls, had been designed and built by Messrs. J. Frerichs & Company, of Osterholz-Scharmbeck and Einswarden. The *Frerichs* was a single-screw vessel, built to the rules of the Germanischer Lloyd for the small coasting trade. She had been at work since the spring of this year in the towing service and in keeping up communication between the banks of the river. She had a reversible four-cylinder Diesel motor of 200 horsepower maximum, making 360 revolutions per minute. The motive medium here used was gas-oil, one ton of which was stored in two tanks under the cabin. This amount, which might easily have been doubled, gave the vessel a radius of action of 240 nautical miles at a speed of 9.5

knots. The vessel had a funnel for carrying off the gases. There was abundance of room owing to the small space required for the motive machinery. Reversing was effected by compressed air. A single movement of a lever in the desired direction of motion of the vessel moved the shaft so as to throw the machinery into gear in the manner required. This manipulation was very reliable and could be rapidly performed, if necessary, within a fraction of a second. A special arrangement of the compressor ensured the starting of the motor even if it stopped at a dead point. Cooling water and bilge pumps, which were driven from the crank shaft of the motor, were fixed on the common bed plate. The hot exhaust gases from the cylinder were cooled with water in a double-walled elbow pipe. After being collected into a single pipe they were led into a large condenser, which deadened the noise, and then passed on to the funnel. The bilge pump was used for cooling the exhaust. The compressed air required for some of the maneuvers was produced by the motor itself in a two-stage compressor which formed the fifth cylinder of the installation. It was stored in six large compression vessels in the engine room at the side of the vessel. The air in these was used for starting. In the design of the motor the requirement had been made that there should be as few cylinders and other working parts and as little complications as possible. The adoption of the compressor had enabled the six cylinders otherwise required to be reduced to four, the compressor cylinder being used on occasion for starting the motor when the four-cylinder arrangement did not suffice to avoid the dead-point position. Care had to be taken to keep down expense, which in the construction of the Diesel motor was still a very important consideration. The bed plate was of cast iron and in one piece. The cylinder cover was the most important of the larger castings in the motor, because all the mountings required were attached to it, and great care had to be taken to avoid unnecessary strains in it. The ordinary cast iron used for steam-engine work had been found to be the best material for the cylinder covers. The reversing gear was, in many respects, different from arrangements of the kind hitherto adopted. A horizontal shaft provided with two sets of cams and movable in its axial direction was fitted along the tops of the cylinders. The cams acted on valve levers and were thrown in or out of gear by the shifting of the shaft. The mechanical parts of the gearing were dealt with by the author in detail and illustrated by lettered sketches, from which it appeared that the cams effected the admission of fuel in either end position of the shaft, while there was a neutral position half-way between these. The actuating lever, arranged in the form of a hand wheel, admitted compressed air to the one or other side of the piston of a cylinder. The piston acted on a system of swinging levers, which moved the shaft above mentioned. A glycerine brake at the lower end of the compressed air cylinder provided against sudden jerks or uneasy motion in reversing. Arrangements were made by the admission of smaller amounts of fuel for driving the motor at "half-power" and "slowly," respectively. The air compressor, which, as already mentioned, took the form of a fifth cylinder with a crank on the main shaft arranged at an angle of 90 degrees with those of the motor, so as to have turning power when the latter were at the dead-point position, could, in the latter case, be used for starting by the admission of compressed air into it from the storage tanks. Each working cylinder was provided with a pump which supplied it with the exact quantity of fuel required. For driving these only two eccentrics were necessary, since each of them actuated a double piston, and the pumps were combined in such a way that the regulation of one-half of them was effected from the other half. The body of the pump was of wrought iron in each case. The regulation was effected by means of a simple governor; or it could be done by hand, in which latter case the governor was merely a safeguard against racing of the engine. In connection with diagrams which were shown the lecturer pointed out that in the case of quickly-running motors the combustion could not be so complete as in that of slowly-running ones, and that the combustion and expansion periods ran into one another. The *Frerichs* had been at work for a considerable time with good results, and after careful investigations made with her the insurance companies had agreed to a premium at the ordinary rate. The full speed of 10 knots could be reduced to 3.8 knots, the revolutions per minute thereby falling from 360 to 150. The reduction could be effected either by cutting out some of the cylinders or by supplying smaller quantities of fuel to all of them. Experiments with the reversing gear showed that the lever could be put over in less than a second. The time required for reversing the motor when running at full speed was 8 seconds; while the vessel herself began to go astern after about 27 seconds. The diameter of the turning circle of the vessel was about one and a-half times her length.

The lecturer then directed attention to the Diesel motor fishing boat *Ewersand,* and said that the introduction of the crude oil motor into the fishing industry was an event of first-rate importance. He looked forward to the time when the German fish market would be entirely supplied by means of cheaply worked German motor fishing boats, instead of, as at present, having to draw its supplies largely from abroad. Towards the end of October this vessel had returned from a trial fishing cruise of five weeks, during which time she had not used more than three tons of crude oil, in place of the 20 tons of coal which a steam vessel of the same size would have required. It was anticipated that this amount could be still further reduced. The fishing winches, which might easily have been driven from the motor, were, as a matter of precaution for the first cruise, served by a small donkey boiler. The fuel was stored in a fixed tank in the engine-room, and the small space occupied by it would have been useless for other purposes. The stowing of part of the fuel in the herring-barrels now became unnecessary. The use of crude oil at sea was found to be in every respect reliable, and it was considered as certain that the motor would take the place of the steam engine in fishing vessels. The design was for the most part similar to that in the *Frerichs.* The high-speed two-cylinder motor developed 80 to 90 effective horsepower with 330 revolutions. Reversing was effected by means of a friction coupling and gear. This enabled the motor to be of extremely simple design, and to have relatively few cylinders, which, for the hard usage it would get in a fishing-boat, was of great importance.

Herr Saiuberlich gave some further particulars that were not contained in the printed pamphlet distributed. In the course of a comparison of designs for a vessel for shipyard work with a Diesel motor and with a steam engine, it appeared that, with a given output of 100 horsepower, 11½ feet of length of hull and one stoker could be saved by the adoption of the new motor. A herring boat of 164 tons, with a steam engine, was found to be capable of doing only the same work as a vessel of the same kind of 140 tons with a Diesel motor. In a trawler, the substitution of a Diesel motor for a steam engine increased the length of the available hold by 13 feet. In a vessel of 5,400 tons for the Black Sea trade, 15,000 cubic feet were added to the hold space by the adoption of a Diesel motor. Assuming the vessel to make four voyages a year, this was equivalent to a profit of $4,380 (£900); the saving in fuel due to the Diesel motor for these voyages was $2,677 (£550), and about $1,168 (£240) in wages. In view of these facts, the author was of opinion that the applicability of the Diesel motor to ships was very great.

In reference to the paper, Professor Flamm observed that the opinion of Herr Saiuberlich that the Diesel motor had a

great future before is as a marine engine was shared by very many, but in answer to inquiries addressed to motor-making firms he had not yet succeeded in obtaining offers that showed to such advantage as the statements they had just heard. In the case of a fishing vessel it appeared that, as regards weight, the great advantage claimed was not obtainable. A motor of 100 horsepower had been offered for $12,897 (£2650). Only one firm was willing to take back the motor in case it should not have fulfilled the requirements after a year's trial. The prices asked for the motor, then, were considerably higher than those ruling for steam engines. The working expenses were less, it was true, but not to such a degree that it could be predicted therefrom that the Diesel motor would drive out the steam engine. He believed that the adherents of the motor would further their cause more if they gave figures that applied to results over a considerable length of time, instead of experimental data; unpleasant disappointments would then be avoided.

A FLYING MOTOR BOAT.

BY FRANK C. PERKINS.

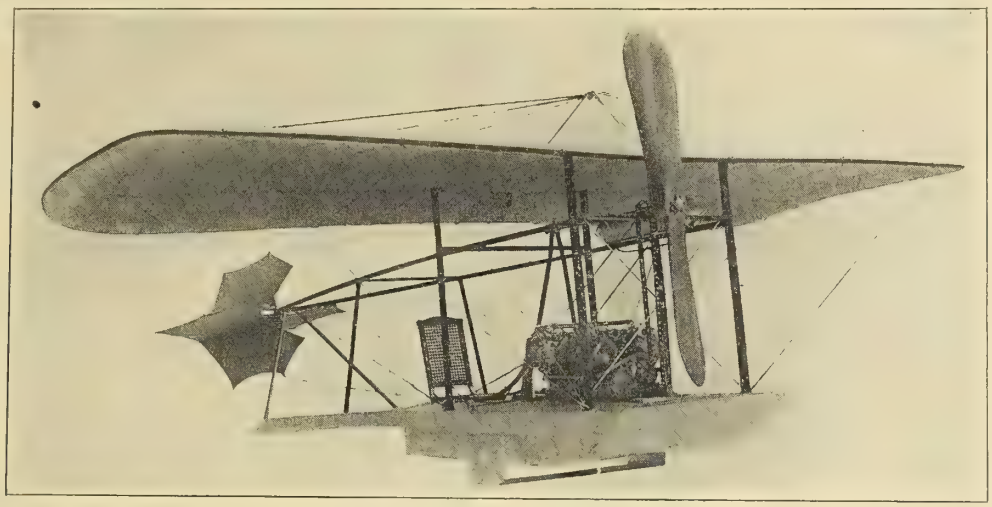
It is maintained that the flying motor boat or combination aeroplane and high-speed water craft shown in the accompanying illustration will revolutionize to a marked degree transportation over the water both for pleasure and business.

other angles are 90 degrees. In front of the hull is set an eight-cylinder aeroplane motor, which operates the propelling power. This outfit has no water propeller, but is propelled by a large two-bladed air propeller measuring more than 6 feet from tip to tip. This wheel is turned at a terrific speed by the eight-cylinder motor installed.

In the photograph it will be seen that above the hull is arranged the single plane, measuring 26 feet and 6½ feet wide. The frame is covered with oil-soaked khaki. The shape is convex. Extending behind the hull is the tail, for all the world like the handles of a baby buggy, except that the arms are steel and the wooden cross-piece is a foot wide. On this flat board 5 feet 7 inches long, a foot wide and ½ inch thick about 10 feet behind the hull, the craft rests upon when under way, that is, when the boat attains sufficient speed forward, the plane lifts the hull out of the water entirely, leaving it resting only on its tail feathers touching the surface.

It is said that, as the speed of the boat increases, the "Flying Fish" rises from the water entirely and leaps over the top of the water in bounds, with the tail feathers on the rear touching the water at intervals and steadying the flight.

It is maintained that the boat is not expected to fly at any great distance or at any great height. The rush of air catches the plane and lifts it up 8 or 10 feet at times. The tail piece, however, is always in the water, controlling her equilibrium perfectly. Extending from the stern of the hull is the rudder. The rudder is a regular aeroplane rudder, but smaller, four-



FLYING MOTOR BOAT "FLYING FISH."

It is stated that this craft has been thoroughly tried out, and has shown remarkable speed and stability, is called "The Flying Fish."

It is interesting to note that A. A. Schantz, president of the Detroit and Cleveland Aerial Navigation Company, has arranged for six of these equipments to be used in daily service between Detroit, Cleveland and Buffalo.

This combination air and water craft is built along the lines of a giant bird. The construction is a combination of the monoplane and hydroplane, designed to skim along the surface of the water, literally on its tail feathers, at a speed of from 65 to 70 miles per hour.

The first working model was taken out on the Detroit River, and skimmed over the ice, scarcely touching it, at an approximate speed of 60 miles per hour. This outfit was equipped with a less powerful engine than the present craft is equipped with, and it is expected that this new model will be of great interest throughout the world.

It may be stated that the hull of "The Flying Fish" is a water-tight, aluminum tank 5 feet 7 inches wide, 7 feet 2 inches long and 2 feet deep. The bow end is curved, but all

vaned, blades being covered with canvas. The cockpit is in the stern of the hull, into which the feet of the skipper extend as he sits in the small caned back chain balanced on the stern rail. The levers for controlling the rudder and plane are all under one man's control, and complete the craft weighs 750 pounds.

It is believed that the possibilities of this invention are wonderful, both from a business and pleasure standpoint, as "The Frying Fish" will float perfectly on the water and there is less danger of tipping than in any other boat, for the plane will act as a preventer. In this boat the passengers will have all the sensations of flying, but there will be something more substantial than air to fall on should anything go wrong.

It is held that, while the first model was a small one, a larger craft has been designed, as noted in the picture, in which four or five passengers can be carried by the Detroit and Cleveland Aerial Navigation Company for daily service between Detroit, Cleveland and Buffalo. This company is very enthusiastic over the new device, and the idea is to have five or six aeroplanes or airships in operation in connection with lake boats.

VANADIUM STEEL IS EFFICIENCY STEEL

The recognition of Vanadium as an alloy for producing the most efficient types of steel known, has been fully granted by metallurgists and manufacturers all over the world. Many steel makers have found Vanadium such a valuable alloy that they have established totally new types of steel upon its qualities and given special trade-marked names to such steels. Whatever the name may be, it is important for you to insist that your steel contains Vanadium as you will then get the maximum efficiency as far as strength, toughness and durability are concerned.

Every reputable manufacturer now makes or uses Vanadium Steels. You can buy Vanadium Steels in which "Amervan" Ferro Vanadium, "The Master Alloy," is used from the following, and many others:

Vanadium Cast Iron.

W. P. Taylor Co.	Buffalo, N. Y.
Manufacturers Foundry Co.	Waterbury, Conn.
Capitol Foundry Co.	Hartford, Conn.
Rosedale Foundry and Machine Co.	Pittsburgh, Pa.
Ross-Meehan Foundry Co.	Chattanooga, Tenn.
Du Bois Foundry Co.	Cold Spring, N. Y.

Vanadium Cast Steel—Crucible.

Sivyer Steel Casting Co.	Milwaukee, Wis.
Riverside Steel Casting Co.	Newark, N. J.
Crucible Steel Casting Co.	Lansdowne, Pa.
Damascus Crucible Steel Casting Co.	New Brighton, Pa.
Lebanon Steel Casting Co.	Lebanon, Pa.
Michigan Crucible Steel Casting Co.	Detroit, Mich.
West Steel Casting Co.	Cleveland, O.

Vanadium Cast Steel—Open Hearth.

Union Steel Casting Co.	Pittsburgh, Pa.
Mesta Machine Co.	Pittsburgh, Pa.
Mackintosh-Hemphill Co.	Pittsburgh, Pa.
Penn Steel Casting and Machine Co.	Chester, Pa.
American Steel Foundries Co.	Chicago, Ill.
Pittsburgh Steel Foundries	Pittsburgh, Pa.
Pratt & Letchworth	Buffalo, N. Y.

Vanadium Malleable Iron.

(See Cast Iron)

Vanadium Tool Steel.

Bethlehem Steel Co.	South Bethlehem, Pa.
Crucible Steel Co. of America	Pittsburgh, Pa.
Colonial Steel Co.	Pittsburgh, Pa.
Vanadium-Alloys Steel Co.	Latrobe, Pa.
Heller Bros. Co.	Newark, N. J.
Vulcan Crucible Steel Co.	Aliquippa, Pa.
Cyclops Steel Co.	Titusville, Pa.
Halcomb Steel Co.	Syracuse, N. Y.

Vanadium Forgings, Crank Shafts, Axles, Piston Rods, Etc.

Carnegie Steel Co.	Pittsburgh, Pa.
American Locomotive Co.	New York, N. Y.
Mesta Machine Co.	Pittsburgh, Pa.
L. L. Driggs & Co.	New York, N. Y.
Erie Forge Co.	Erie, Pa.

Drop Forgings, Gears, Etc.

Driggs Seabury Ordnance Corporation	Sharon, Pa.
L. L. Driggs & Co.	New York, N. Y.
Transue-Williams Co.	Alliance, Ohio.
Wyman-Gordon Co.	Worcester, Mass.
Crescent Drop Forge Co.	Hulton, Pa.
Baker Drop Forge Co.	Jackson, Mich.
Warner Gear Co.	Muncie, Ind.
J. H. Williams & Co.	Brooklyn, N. Y.

Vanadium Automobile Cylinders.

Capitol Foundry Co.	Hartford, Conn.
W. P. Taylor Co.	Buffalo, N. Y.
Manufacturers Foundry Co.	Waterbury, Conn.
Du Bois Foundry Co.	Cold Spring, N. Y.

Vanadium Miscellaneous Shapes.

Carnegie Steel Co.	Pittsburgh, Pa.
Bethlehem Steel Co.	South Bethlehem, Pa.
Crucible Steel Co. of America	Pittsburgh, Pa.
Colonial Steel Co.	Pittsburgh, Pa.
Vanadium-Alloys-Steel Co.	Latrobe, Pa.
Halcomb Steel Co.	Syracuse, N. Y.
Vulcan Crucible Steel Co.	Aliquippa, Pa.
United Steel Co.	Canton, Ohio
Firth Sterling Steel Co.	McKeesport, Pa.
Midvale Steel Co.	Philadelphia, Pa.

Write any of these companies for information on Vanadium Steel.

AMERICAN VANADIUM COMPANY

Miners of Vanadium Ores
Largest producers of Vanadium Alloys in the World
Entire product sold by the Vanadium Sales Co. of America
318 Frick Building
PITTSBURGH, PENNA.

VANADIUM METALS COMPANY

FRICK BUILDING, PITTSBURGH, PA., U.S.A.

FOUNDRY, EAST BRAINTREE, MASS.

REMARKABLE ECONOMY OF AN OIL FUEL INSTALLATION.

Every engineer knows or believes that oil fuel is in many instances much more economical than coal, and the following description will cover what is presumed to be a noteworthy example to aid this general belief. Furthermore, it is thought that the method of application to be described is the first instance of the use of one of its kind; at any event, the writer has no knowledge of a similar oil fuel burning plant.

The revenue cutter *Golden Gate,* on which this successful experiment has been tried, is a vessel of the ordinary harbor tug type, and is engaged in boarding duty in San Francisco harbor. This is an intermittent duty, involving daily a number of short trips around the harbor, a state of readiness to go at a moment's notice, and consequent lying at a wharf with steam up for the greater portion of the time. This tug is 110 feet long, and up to six months ago was provided with a watertube boiler of the Ward type, and a triple-expansion engine capable of producing 550 maximum indicated horsepower. The subject of oil fuel for the *Golden Gate* had been frequently

REVENUE CUTTER GOLDEN GATE.

transforming the coal bunkers into oil tanks was $15,000 (£3,000), an amount deemed prohibitive in view of the small sums available for repairs, and to the further fact that the vessel when new in 1896 cost only $50,000 (£10,000). As the old boiler had to be renewed last year, a new Babcock & Wilcox watertube boiler was installed, and during its installation the following scheme was thought out and put into application:

A small cylindrical tank, with a capacity of approximately twenty-three barrels of oil, was installed in the fireroom, well up under the deck beams (as shown in the accompanying plans), so as not to interfere with the withdrawal of the boiler tubes when necessary. Immediately under the tank was installed a No. 10, S. & P. oil pump, with the necessary heater, coil, governor, relief, gage, tank, strainers, etc.

The boiler is equipped with grate bars, etc., complete, the same as it would be for burning coal, with the exception that fire bricks are laid over the grate bars. The burners are spaced about 2 feet apart, project 12 inches beyond the door frame liners and are about 6 inches above the level of the grates, slanting slightly downward. The entire installation for burning oil, including the tank and its supports and all incidental expenses necessary to make the apparatus ready for use, was only $2,500 (£500). The advantage of this installation may be summarized as follows:

(1) Its non-interference with the coal-burning appliances; the regular coal bunkers not being disturbed, and, in fact, 10 tons of coal are carried in bags to trim the ship. In case the oil supply should run out, coal could be immediately burned, after removing the fire bricks off the grate bars and disconnecting the oil burners. If the vessel should go on a long voyage or be transferred to some port where fuel oil was not available there would be nothing to interfere with coal burning.

(2) The oil supply, small as it is, is sufficient for four or five days' steaming under ordinary circumstances. The oil is furnished from a pipe line on the wharf, where the *Golden Gate* is moored, and the tank can be filled in ten minutes.

(3) Owing to the small amount of oil carried the danger from fire is minimized.

(4) The great decrease in cost of installation; $2,500 (£500) for complete apparatus, as against $15,000 (£3,000) for the cost of tanks alone, if the coal bunkers had been transformed into oil tanks.

(5) The marked saving in fuel bills when compared with coal, as will now be shown.

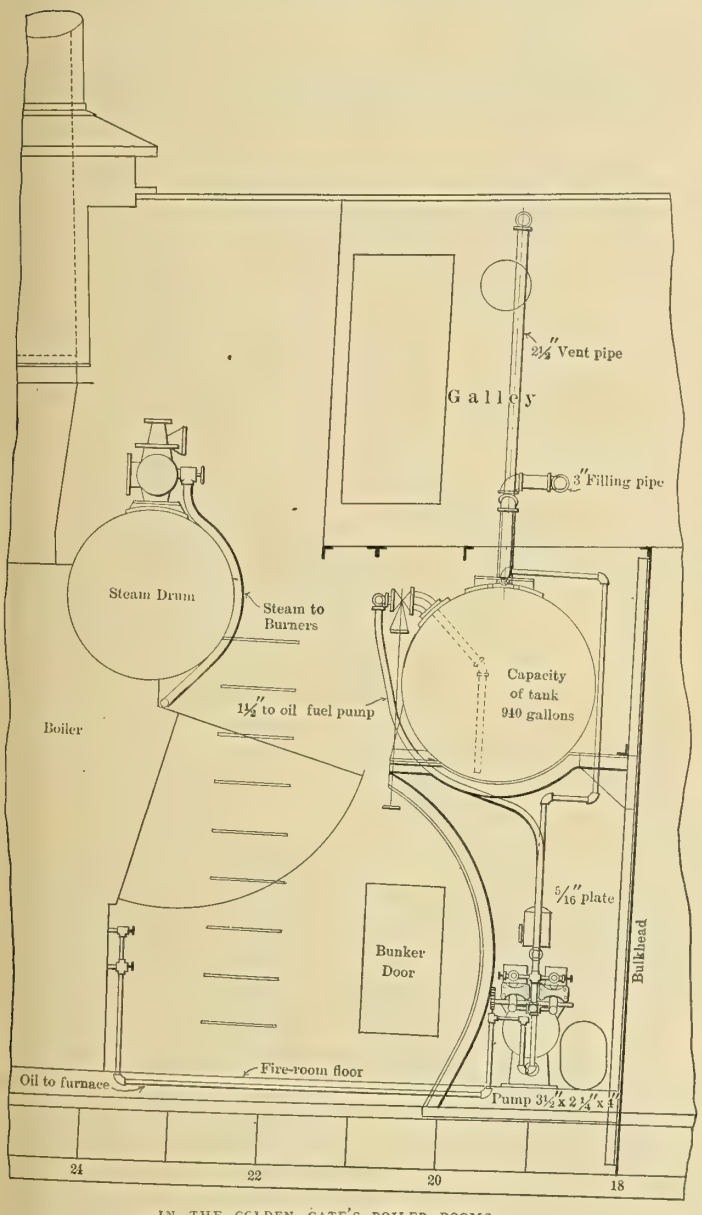
RELATIVE FUEL CONSUMPTION FOR THREE MONTHS, ENDING DEC. 31, 1909, AND DEC. 31, 1910.

	1909 (With Coal.)	1910 (With Oil.)
Banked fires	1,945 hrs. 45 min.	1,705 hrs. 45 min.
Underway	238 hrs. 15 min.	190 hrs. 15 min
Total miles steamed	2,030	1,604
Fuel expense	128.6 tons	253.7 bbls.
Cost of coal at $5.40 (£1 2s.) per ton		$694.44 (£138 9s.)
Cost of oil at $ .60 (2/6) per bbl		153.32 (£ 30 10s.)
Net saving for 3 months		$541.12 (£108 10s.)
Percentage saved by use of oil		77.8

It will be seen from the above tabulation that during the period in question the vessel did not steam as many miles under oil fuel as she did under coal, nor was she so long under banked fires. A much better comparison as to the relative cost of coal and oil as fuels can be deducted from the performances of November, 1909, and November, 1910, which were as follows:

	November, 1909 (With Coal.)	November, 1910 (With Oil.)
Hours underway per day, average	4	3
Knots per hour	8.5	8.5
Total miles cruised per day	34	25.5
Banked fires, hours	620.5	464.2
Fuel used per day, average, lbs.	4,726	1,205
Fuel used per day while underway	3,600	975
Fuel used per day under banked fires	1,126	230
Cost of fuel per day for steaming (coal at $5.40 per ton)	$8.40	
Cost of fuel per day for steaming (oil at $.60 per bbl.)		$1.73
Cost per mile	24 cts.	6.9 cts.
Cost of oil compared with coal, per mile, percent	28	
Saving per mile, per cent	72	
Miles steamed per ton of coal at 8.5 knots	21.2	
Miles steamed per ton of oil at 8.5 knots	58.5	

From the foregoing tabulation it is clear that the cost of the oil fuel is only slightly in excess of one-fourth the cost



IN THE GOLDEN GATE'S BOILER ROOMS.

of coal under the former condition, which, to say the least, is a remarkable saving. A further reduction in the cost of operation of the machinery, due to the use of oil fuel, comes from the fact that the personnel has been reduced from four men to three, by dispensing with the services of one coal passer, whose annual wages, subsistence, etc., cost the government $674 (£141).

At the saving indicated by the returns from the first quarter of the operation of the oil plant there will undoubtedly be an annual saving in fuel of $2,160 (£432); this, with the reduction of $674 (£141) for labor, will make an annual saving of $2,834 (£567), due almost entirely to the installation of apparatus, the first cost of which was only $2,500 (£500).

The following notes and excerpts from the report of the engineer officer in charge of the steam machinery may prove of interest in connection with the operation of this plant, viz.:

The new boiler is well adapted for the use of oil as fuel, because of the flame-baffling system, combined with the large volume of the combustion chamber. This allows the sprayed oil ample opportunity to effect a complete combustion and passes the products of combustion to the stack at a low temperature. Under ordinary conditions there is no smoke. After the boilers had been in operation for two months the quantity of dirt and soot removed would not fill a two-quart can. The heating surfaces were almost as clean as when new, while, with coal, they would have been congested with soot.

With oil the steam pressure can be kept stationary, while the machinery can respond to unusual or varying demands.

A great economy is effected through the careful use of the damper. The fire bricks act as an accumulator of heat, and about 20 gallons of oil will maintain steam at about 100 pounds pressure for twenty-four hours, thus holding steam easily at night.

From water at 56 degrees F., steam is raised in one hour with the middle burner operated as slowly as possible and using an inappreciable amount of oil.

The proper adjustment of the fire bricks over the grate bars is important. They are laid flat and lengthwise across the grates. The five rows back are laid close together, and three extra rows are added for ordinary steaming. The remainder are laid in the same manner, with a space of 3 to 4 inches between each new row, depending on the amount of air required. If too much air is admitted, oil is wasted; and if too little, the burners give out a dark flame and sputter. The air supply must be balanced with the steam supply to get the best results.

The oil in the tank is about 80 degrees F. It is delivered to the burners at about 150 degrees F., under a pressure of 40 to 60 pounds, depending on the work required.

The efficiency of the entire system is dependent on the regularity of the oil supply. If through any cause the pump is not operated uniformly, no amount of attention will avail at the burners.

The oil used is the California product known as "Richmond Fuel," and the following are its physical properties and chemical analysis:

ULTIMATE ANALYSIS.		PHYSICAL PROPERTIES.	
Carbon	87.78%	Specific gravity	0.952
Hydrogen	10.75%	Flash point	190-F.
Sulphur	.75%	Fire point	280-F.
Nitrogen	.34%	Calorific value B. T. U.	18,648
Oxygen	.38%		
Moisture	.10%		

There are a lot of notes and tables which are of almost daily use. Handled by dirty hands these soon become so soiled that they cannot be read easily, if at all. It is but a slight improvement to varnish them. The best thing is not to handle them at all. This can easily be accomplished by placing them face up on the desk with a piece of plate or double thick glass on top. A small rim of wood should be nailed around the glass to keep it from sliding off. Where the lid of the desk is hinged the wooden border should have a small lip to hold the glass down upon it.

THE MARINE STEAM ENGINE INDICATOR—XX.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

THE COUNTER PRESSURE LINE.

Under ideal conditions, and at the moment when the crank pin is crossing the dead center, the pressure in the cylinder should be almost, if not quite, as low as that in the chamber into which the exhaust passage leads. If this condition exists and the port opening is ample, the piston will meet with very little resistance due to steam friction. In fact, the difference in pressure necessary to produce a flow from the cylinder to the exhaust pipe or receiver will be so small that it will be hardly measureable, and the counter pressure or back pressure line** will be straight and parallel to the atmospheric line, as shown at *I*, Fig. 106.

If release is late and the valve opens slowly, but eventually

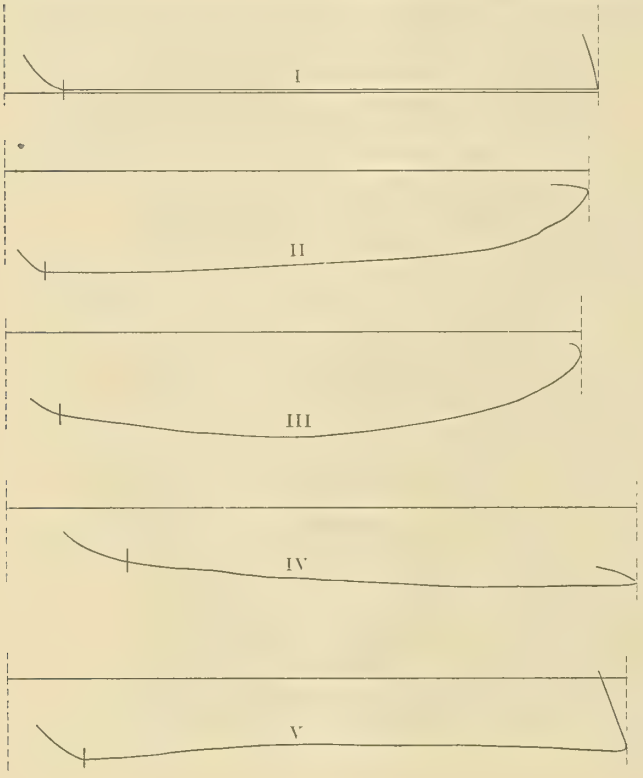


FIG. 106.

gives a good port opening, the counter pressure line will resemble *II*, while, if the line is like *III*, it indicates a restricted passage at each end of the stroke. If release is early and the steam speed high near the middle of the stroke, the counter pressure line will slope upward from the "toe," due to excessive steam friction near the middle, and to cramping of the exhaust near the end of the stroke, when the exhaust port narrows for compression while the piston speed is yet relatively high. (See *IV*.)

The designed velocity for exhaust steam through ports and passages is commonly as low as 4,000 feet per minute, and in land practice this rule is very generally observed. On shipboard, however, on account of lack of space and necessary weight limitation, it is practically impossible to provide passages sufficiently large for this low velocity. This is especially true in the design of intermediate and low-pressure cylinders of high-speed engines.

As an example taken from actual work, the following exhaust steam speeds should be carefully noted as representing good modern practice in two widely differing types of propelling machinery. The speeds given are in feet per minute, with the engines at maximum power:

MERCHANT MARINE TYPE, VERTICAL TRIPLE, ONE LOW-PRESSURE CYLINDER.

Exhaust from high-pressure cylinder	4120
Exhaust from medium-pressure cylinder	5375
Exhaust from low-pressure cylinder	6830
Exhaust pipe, low-pressure, valve chest to condenser	4975

NAVAL TYPE, VERTICAL TRIPLE, TWO LOW-PRESSURE CYLINDERS.

Exhaust from high-pressure cylinder	5700
Exhaust from medium-pressure cylinder	6900
Exhaust from low-pressure cylinder	8580
Exhaust pipe, low-pressure, valve chest to condenser	7200

The higher steam speeds in the naval engine are due to the fact that military necessity requires some sacrifice of efficiency in the machinery, in order that space may be saved, and all

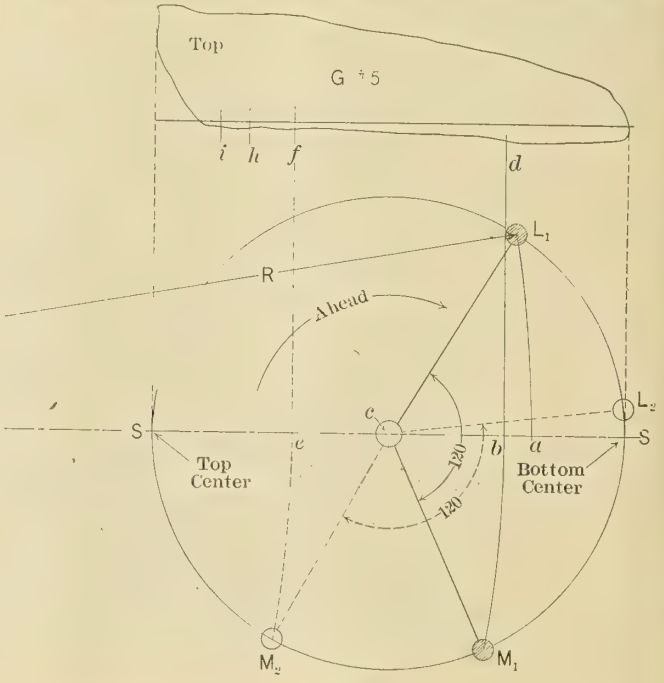


FIG. 107.

possible weight used in armor and armament without increasing the total weight of the vessel. These facts are mentioned in order that the reader may not be led to expect indicator diagrams from marine engines, which will compare favorably with those taken from land engines, which have been worked out without the same restrictions as to weight or space.

With regard to steam speeds in general, it should be noted that the velocities are average velocities, and account should be taken of the fact that steam and piston speeds increase from zero at the ends to a maximum near the middle of the stroke.

On diagrams taken from engines running at such speeds, that the steam velocities are excessive, we often see counter pressure lines like *V*. This line shows in a beautiful manner the banking up of the pressure near the middle of the stroke, due to the necessarily rapid flow of the exhaust through the ports at that part of the stroke when the piston speed is highest.

In the case of cylinders exhausting into receivers from which other engines take steam, the counter pressure is affected by the position of the engine cranks relative to each other, by the receiver capacity, and the order in which the various valve events occur. Refer to Fig. 107. When cut-off

* Copyright, 1911, by Charles S. Root.
** E. F. of Fig. 95, September, 1910.

occurs in the low-pressure cylinder, the low-pressure piston is at *a* on the line of stroke *S S*, and approaching the bottom center. On this particular engine the length of the connecting rod *R* is five times the radius of the crank *c* L_1. With this length as a radius and a center located on *S S*, produced, sweep in the arc *a* L_1, cutting the circle, representing the path of the crank pin, at L_1, this locating the low-pressure crank pin at the moment of cut-off in the low-pressure cylinder. Draw *c* L_1, the center line of the low-pressure crank web. Lay off 120 degrees in the direction of rotation and mark M_1. This is the position of the medium-pressure crank pin at the instant of low-pressure cut-off. With the length of the connecting rod as before sweep in the arc M_1 *b*. This locates the medium-pressure piston at *b* at the instant of cut-off in the low-pressure. Draw *b d* at right angles to *S S*, and produce it to cut the counter pressure line of the indicator diagram. It will be noticed that the counter pressure begins to increase at this point. This is because the escape of steam from receiver has been stopped by the closing of the low-pressure valve, while steam continues to flow into it from the medium-pressure cylinder. In other words, the medium-pressure piston is compressing the steam in the low-pressure receiver. The counter pressure reaches a maximum at *f*. When the low-pressure crank pin reaches L_2, the low-pressure engine commences to take steam for the up-stroke. The corresponding position for the medium-pressure crank pin is M_2, with the medium pres-piston on the line *e f*. The counter pressure line begins to fall after passing *f*, due to the steam flowing into the low-pressure cylinder, but as the capacity of the cylinder is comparatively small and the piston speed low up to this point, the drop in the receiver pressure is not abrupt. At *h* the medium-pressure exhaust begins to "wire draw," though the nearly-closed exhaust port and the influence of the receiver pressure on the cylinder pressure is at an end. Compression begins at *i*. At the time the diagram of Fig. 107 was taken, the engine was running at only one-third power; steam speeds were low, and wire-drawing, due to high steam speeds, does not complicate the diagram.

The diagram of Fig. 100* shows the characteristic "hump" in the back pressure line in a very marked degree. In this instance the low-pressure valve was out of position owing to the wearing down of the gear. This caused a very late cut-off on the down stroke of the low-pressure, and the "hump" in the medium-presure counter pressure line is nearer the end of the medium-pressure up-stroke than in Fig. 107. The low-pressure bottom admission does not begin until about the time of compression in the medium-pressure, and, in consequence, the drop in the receiver pressure at this point does not appear on the card.

While the counter pressure in the low-pressure engine is not affected as that of the other engines by a varying receiver pressure, it is, of course, influenced by the condenser pressure, and it may not be out of place here to say a few words relative to the best vacuum to carry.

The flow of steam increases with difference in pressure until the lower pressure drops to about 58 percent of the higher pressure. With a greater difference the rate of flow does not increase, even though a nearly perfect vacuum be maintained in the condenser. In consequence, a better vacuum than is usually carried does not always result in lowering the counter pressure line in the low-pressure cylinder, although it does increase the load on the air pump. It is, therefore, desirable to carry that vacuum, which, if decreased at all, will produce a rise in the low-pressure counter pressure line and which, if increased, will result in no lowering of that line. This certain condenser pressure—which will be called the *economical* vacuum for want of a better term—is different for different engines and differs in the same engine when at different speeds. The economical vacuum should be determined for every installation when operating at the regular sea speed, and when once established should be maintained if it does not result in hot-well temperatures which are not permissible. The proper vacuum may be easily found by applying the indicator to the low-pressure cylinder and varying the vacuum until the correct point is found. In this way it will be possible to obtain minimum counter pressure in the main engines with the least possible load on the air and circulating pumps.

(To be continued.)

* December, 1910, issue.

Passenger and Freight Steamship Suwannee.

The Merchants & Miners Transportation Company, of Baltimore, has just added a handsome passenger and freight steamship to its fleet trading between Savannah and Baltimore. The vessel was built at the yards of the New York Shipbuilding

LAUNCHING OF S. S. SUWANNEE.

Company, Camden, N. J., U. S. A., and is of the following dimensions:

Length over all	331 feet
Length B. P.	318 feet
Beam molded	46 feet
Depth molded to huricane deck	30 feet

The vessel is especially adapted for the coastwise trade and has been built to the rules of the American Bureau of Shipping, under special survey; the requirements of the Board of Supervising Inspectors of Steam Vessels for the equipment, etc., have also been fully complied with. The arrangement of accommodation is such as will give every comfort and convenience to the passengers, and provision is made for 150 first class passengers, 20 deck passengers, and crew and stewards' department, 56; a total complement of 226.

The cargo holds, ports and hatches are so arranged as to facilitate the handling of freight, and steam winches, cranes, etc., are fitted in connection with the same.

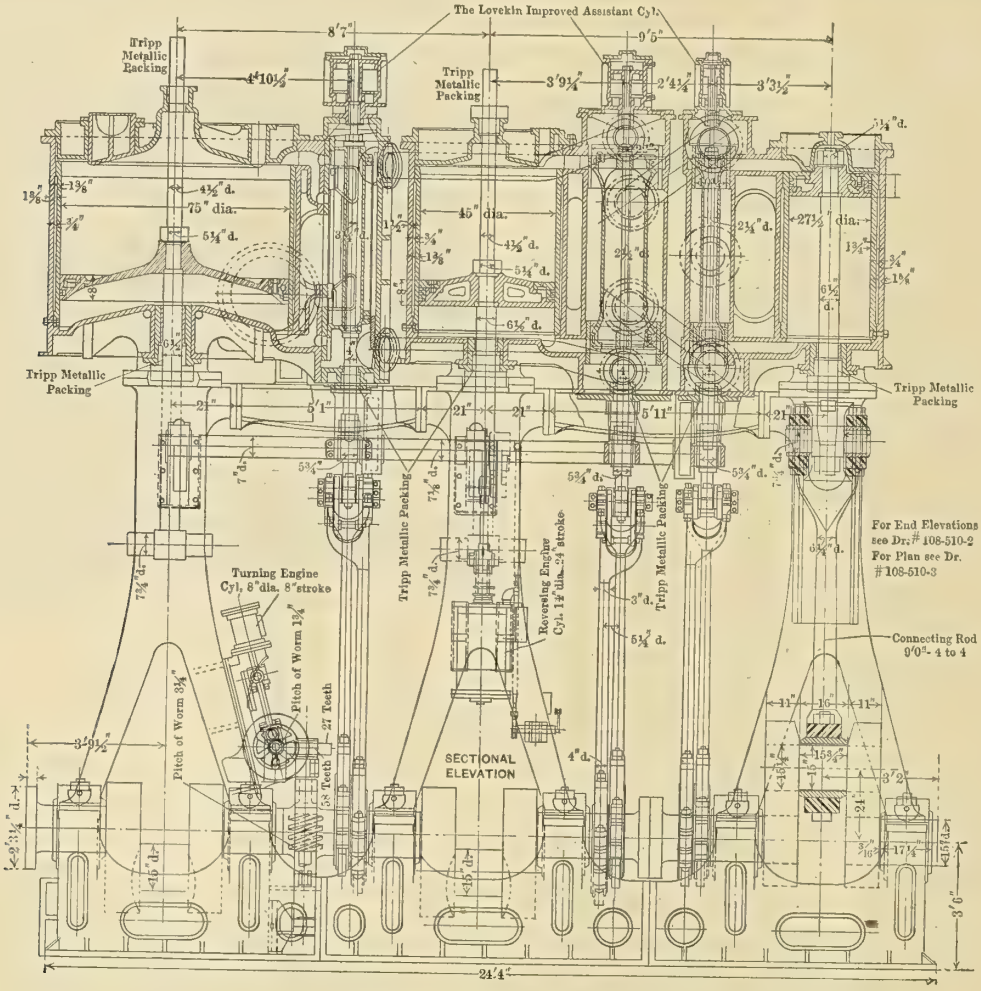
The propelling machinery is located amidships and consists of a three-cylinder reciprocating engine and four single-ended Scotch boilers. A double bottom is arranged in way of the machinery space for the carriage of reserve feed water, and all fore and aft for the purpose of trucking freight, and three large cargo ports are fitted on each side. A double bottom is fitted under the engine room, on the cellular principle with floors on every frame. The promenade and boat decks on top

S. S. SUWANNEE BEING FITTED OUT.

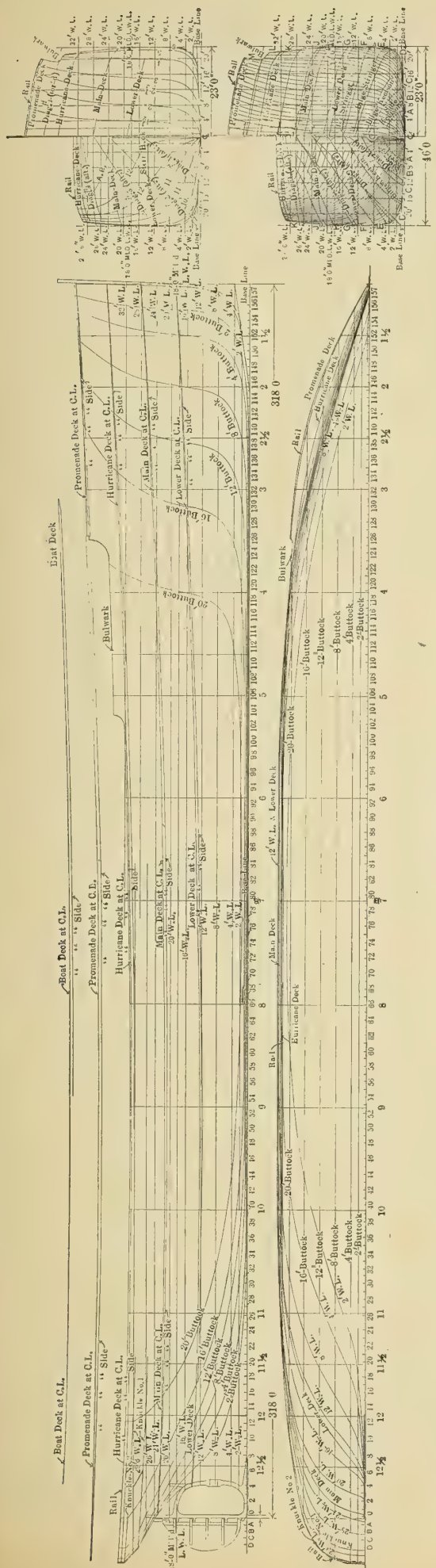
the peaks are also fitted as tanks. For the drinking water and for sanitary service separate tanks are provided.

Hull Construction.—The vessel has complete steel main deck all fore and aft, lower deck at ends forward and abaft of machinery spaces, and hurricane deck of steel stringers, ties and beams with wood decking all fore and aft. The vessel is subdivided by five steel watertight bulkheads, all carried to the main deck. The main 'tween decks are clear of obstruction of deck houses are carried out to the side of the vessel and are of light joiner construction.

Passenger Accommodations.—Accommodations for 150 first class passengers are all located in deck houses on the hurricane and promenade decks, there being 65 state rooms, four of these being arranged en suite, with special fittings and adjoining bathrooms, and four are extra large individual state rooms with toilet and shower bath to each. A spacious



ENGINE OF S. S. SUWANNEE.



LINES OF MERCHANTS & MINERS S. S. SUWANNEE.

dining saloon is fitted on the hurricane deck capable of seating 82 persons, and a large social hall and smoking room are fitted up on the promenade deck, stairways and lobbies forming entrances to the same. Dome skylights add to the decoratice effect in these spaces. The 20 second class passengers are berthed in two rooms in the forecastle on the hurricane deck, the smaller of the two being reserved for ladies and provided with four berths, with toilet adjoining.

The captain and officers are located in a deckhouse on the forward part of the boat deck, with pilot house at the forward end.

The engineers are in deckhouses at the sides of the casings on the promenade deck, and the galley, pantry and stewards' staff are located on the hurricane deck alongside casings. The waiters, seamen and firemen are berthed in the forecastle on the hurricane deck. All modern conveniences are fitted in the state rooms, public rooms, stewards' department, galley and pantry. Built-in ice, fruit and vegetable lockers are also provided.

Cargo Arrangements.—The arrangements for rapid handling of the cargo are very complete. Large cargo hatches are provided to each hold, and radial cranes are fitted on the main deck and forward on hurricane deck to handle the cargo from the holds to the 'tween decks, whence it is trucked ashore through large cargo ports provided for that purpose. Hoisting engines are fitted at each radial crane. The holds have been kept clear of obstructions and the pillars supporting the decks are widely spaced, with overhead girders. A steam windlass is fitted forward with capstan head fited on the forecastle for handling the vessel; the engine and wildcats for handling the anchor cable are below on the hurricane deck. A steam capstan is also fitted aft for handling the vessel. Eight steam cargo winches are fitted, one to each radial crane to the cargo hatches. A steam steering gear is fitted, with auxiliary hand appliances. Life-saving apparatus is provided of ample capacity for the full complement of 226 persons and consists of seven metallic lifeboats and two metallic cylinder life-rafts, also one working boat for the use of the vessel; all boats being handled by Welin quadrant davits. The vessel is equipped with wireless telegraphy.

United States Naval Programme for 1911.

The naval appropriation bill recently passed by Congress contains the following provisions as regards the building of new vessels:

Two first-class battleships, to cost, exclusive of armor and armament, not to exceed the sum of $6,000,000 (£1,200,000) each. The general characteristics of these vessels embody as heavy armor and as powerful armament as any vessels of their class, combined with the greatest possible speed and radius of action.

Two fleet colliers of not less than 12,500 tons displacement, inclusive of bunker coal; the cost not to exceed $1,000,000 (£200,000); and the speed to be 14 knots.

Eight torpedo boat destroyers to cost not more than $825,000 (£165,000) each and to have the highest practicable speed.

Four submarine boats, to cost an aggregate of not exceeding $2,000,000 (£400,000).

One submarine tender, the cost of which must not exceed $500,000 (£100,000).

One gunboat, to cost not to exceed $500,000 (£100,000), which is exclusive of armor and armament.

One river gunboat, to cost not to exceed $225,000 (£45,000), exclusive of armor and armament.

Two sea-going tugs, to cost not to exceed $215,000 (£43,000.)

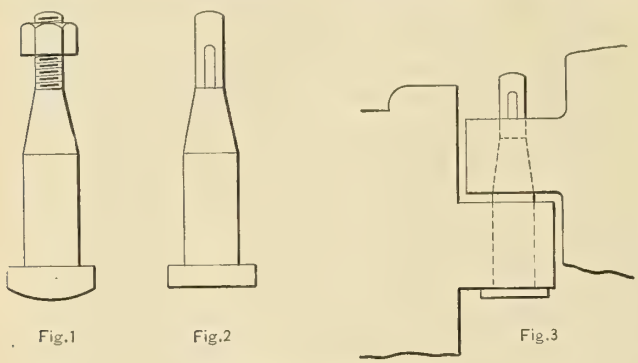
The total amount in the bill is $126,464,338 (£25,292,868), which constitutes the appropriation for the entire naval establishment for the year ending 1912.

PRACTICAL EXPERIENCES OF MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

The Repair of Broken Rudder Pintle Bolts.

It is a very inadvisable thing to have the chains of the steering gear of a vessel too slack, and as a precaution against trouble of this nature it is advisable that springs should be fitted to them. If this is not done there is a considerable amount of danger of the rudder lashing from side to side, more particularly if the ship is light, and if it should happen to be in a heavy following sea. The result of this will probably be that the pintle bolts will be broken, owing to the sudden strain put upon them. In a case of this sort in the



BROKEN RUDDER PINTLE BOLTS.

Atantic two pintle bolts of the shape shown in Fig. 1 were broken and fell out, and as soon as this was noticed the ship had to be stopped. In order to effect a repair which would stand until the vessel reached port, a gangway davit was secured and sawn into two lengths by chipping and filing these up; bolts were made of the shape shown in Fig. 2. As there were no screw-cutting lathes on board ship, it was necessary to cut cotter holes through the top of the bolt, as shown in the figure, and, after waiting until the sea went down a bit, these bolts were put in and secured by means of cotters, as shown in Fig. 3. The cotters had holes drilled in them, into which were placed split pins in order to keep the cotters from working out again, and the repair answered perfectly until the vessel was brought back into port.

Hull. RUDDER.

How a Spare Propeller and Shaft were Fitted at Sea.

We were on a voyage from Bombay to Dundee (Scotland) in ballast trim in the good ship *D*..... It was on this voyage that we lost our propeller, the loss of which was due to the tail end breaking off short just outside the stern tube.

The vessel being in the Indian Ocean and near some very inhospitable islands, noted for their man-eating propensities, and a strong current setting towards those islands, our captain and chief-engineer determined to attempt to fit the spare propeller and tail-end shaft which we had in the hold. This feat we managed to accomplish under very trying conditions, but in an entirely satisfactory manner. In order to prevent the vessel from drifting and rolling, a sea anchor, consisting of a long derrick, having sails, weighted with chains attached to it, was let out, and, as a further preventative, one of the anchors, with 30 fathoms of chain cable, was lowered away. This lessened the leeway considerably, but owing to the boisterous, squally weather the vessel continued to roll easily during the whole of the time the replacing of the propeller at tail-end shaft was carried out.

While the captain and his officers were making preparations for lifting and slinging the propeller, the chief-engineer and his staff were very busy down below disconnecting the shafting and chocking it up; they also rolled the intermediate length to one side and made it fast there. Our next job was to cut a plate off the tunnel top; and, as it turned out, it was a very difficult job owing to its being an inside plate, and now all was made ready for removing the broken shaft. The propeller was then unshipped in the hold and lowered away on to the floor of the hold, with, of course, the large end of the bore up. Having done this, we lifted the spare shaft on end and tried it in the bore of the propeller boss. We had previous to this taken every precaution to see that the taper and key were a good fit. All being now ready for fitting the propeller and shaft, orders were given to fill the fore peak, tanks, and fore hold; the water in the latter was only up to the outside level of the water. All this having been done, we now started to get the broken shaft in, and after about twelve hours' solid work we managed to land it in the hold. A wooden plug was fitted to the shaft hole on the outside; this kept nearly all the water out. Our next job was to get the new shaft into place; this job took us 24 hours' solid work. To finish, we had to make a Muntz metal cap to go over and protect the threads on the nut end of the shaft. This Muntz metal cap was run out flush, with the guard ring pushing the wooden plug out at the same time.

Everything being now ready for fitting the propeller, the difficult and dangerous operation of lifting a mass of metal of some eight tons over the side of the vessel, and passing it under the stern, had to be accomplished while the vessel was rolling in the trough of the sea, which was a very heavy one at the time, and which also prohibited the use of either boats or rafts. As all the hatches were fitted with two derricks, both derricks were utilized for the lift, the two being lashed together at the top and fitted with preventative spans on each, about 6 feet in, both being lifted together. The goose necks being 4 inches in diameter, and extra strong, it was not deemed necessary to add any further support to them. The masts did not go through the deck, but were secured to it by heavy gusset plates, and as the deck was supported by heavy through beams and longitudinals, no further support was added and did not prove necessary.

The purchases used were small mooring wire ropes, fastened to the derrick ends, and acting as top block, and so on, down to the winch barrel. We thought it better to try the gear when fitting the shaft, and this we did, and found it worked very satisfactorily. The propeller was now slung round the boss, the slings being well secured with small chain lashings, all terminating at the top, or key-way up side, so as to be easily undone when the propeller was fitted on to the shaft. In order to steady the derricks when making the lift, the four lifts, four tackles were used as guys, two on each side, these being shifted at one time, as required. At a favorable moment the lift was made, and, when clear of the hatch combings, the derricks were guyed over a little and then the propeller was safely landed and secured on the starboard main deck. The derricks were then guyed further over, a

gin block was made fast to the center eyebolt under the counter and another to the propeller, from which a wire rope tackle was led from the capstan aft, through the starboard fair lead; gin of propeller, then to gin under counter, and the end made fast to the propeller. A large wire rope was then led from the forward capstan over the port bow, right along the whole length of the vessel's side, through the screw aperture and round the starboard quarter and made fast to the propeller boss. A similar wire rope was led from forward along the starboard side and also made fast to the propeller boss.

Every precaution having now been taken to prevent the propeller from swinging and staving in the ship's side, the propeller was lifted, and, at the first roll, it was allowed to slide over the ship's side into the water by lowering away the derrick tackles and starboard forward wire; at the same time the after capstan began to heave on its tackle and the forward capstan on the forward port wire. This immediately brought the propeller well under the counter into a comparatively quiet position. Blocks and tackle having being hung from the eyebolt under the port counter were made fast to the propeller and secured. The lashings were then taken off the derricks, and, after unhooking the port derrick tackle, it was passed over the port counter, through the screw aperture, and made fast to the propeller once more.

Another lift was then made and the propeller was brought into position, blocks being hung from the starboard eyebolt and made fast to the boss. The propeller was thus held up and forward by the derrick tackles, up and aft by the tackle to center eyebolt, up and against the body post by fore-and-aft wires, and sideways by the tackles to the propeller lifting eyebolts.

We encountered considerable trouble in entering the shaft and key into the propeller boss, owing to the inclination of the shaft, due to the tip of the vessel, and we only overcame this by taking off the weight now and again. We took the greatest care in handling the nut, it being securely lashed and made fast to the deck; the lashings were only removed when the nut had been screwed up three turns. To have lost the nut would to us have been just as great a disaster as losing the propeller. After "Monday" had been used vigorously for some time, and the propeller set hard up, the set pin was driven home and the most difficult work completed. The shafting we soon afterwards coupled up, replaced the bearings, warmed the engines through and started them very slowly. The voyage was once more resumed, after the repairs had taken eight days and twenty hours.

When we consider the difficult nature of the work so successfully accomplished and in so short a time, the lifting of a heavy mass of metal from the hold to the stern of a rolling ship, the fitting it on while at work on a plank 6 inches wide, one minute immersed 5 feet in the water alive with all sorts of terrible fish, and the next minute 15 feet in the air, hanging on to a heavy hammer or key or nut, the loss of which meant so much to us and to the success of the whole undertaking, or when we consider the great risk of a sudden storm coming on when the loose propeler was hanging from the stern, the pluck, energy and ingenuity of the captain, the chief-engineer and their respective staffs, will, I think, be appreciated by all in both professions. F. J. S. N.

Liverpool.

A LEAKY CONDENSER.

The tubes of a condenser require cleaning from time to time, and this is an operation that should be gone about with some care. If the steam passes through the tubes they can be sponged out with a solution of soda. If the steam passes around the tubes, the fresh-water side is filled with a solution of soda in fresh water, and this may be boiled. After using soda in the condenser, the interior must be thoroughly washed out to prevent the residual soapy matter entering the boiler. Periodical examinations should be made by taking off the manhole and hand-hole doors, for the purpose of cleaning out the grease deposited in the space provided for the condensed steam, and to examine the zincs and tubes; zincs are fitted in the condenser to arrest the corrosion of the tubes, or of the metal of the condenser set up by galvanic action, and those immersed in the salt water have the shortest life and must be frequently renewed. Where the condenser is separate from the engine frame, it is best to have the tubes and condenser shell of the same or similar metal, but for the sake of economy the shell is generally made of cast iron, but sea water destroys this material in time, rendering it soft and spongy, so that in some cases the metal can be cut with a knife. The zincs are secured as in boilers, in the form of plates, and they are also fitted in the form of rods. The method in the latter case is to provide screwed brass plugs, into which the zinc rods are soldered. The plugs are screwed into certain of the holes for the tube glands and are distributed over the surface of the tube plates. The plugs are provided with a square head for a spanner, and the rods project inwards along the length of tubes; these rods must be frequently renewed.

Before opening out the fresh-water side of a condenser it should be pumped out by whatever means is provided for that purpose, and this amount of fresh water is thus saved. It is also necessary to observe the precaution of airing the condenser after it is opened out, because the action of the water and zinc liberates hydrogen gas, and if a light is introduced for examination of the interior before the hydrogen gas has escaped an explosion may easily occur.

In testing for leaks it is well to remember that the tubes of a condenser are liable to split, and also that in spite of the zincs the material is frequently pitted by corrosion, and pin holes are formed. A very slight leak in the tubes of a condenser will, by accumulation, cause the water in the boilers to be rapidly salted and show a density, therefore the examination of the tubes must be carefully conducted. The method employed to examine the tubes depends on whether the salt water passes through or around them; if the salt water passes around the tubes, and the latter are vertical, the examination is easy. Take off the man-hole doors at the top and bottom, giving access to the steam and fresh-water spaces, and leave the salt-water space in communication with the sea. After a short interval introduce a light under the tubes, dry up the spaces, and look for drips from the tubes; taste the drops of water as they fall, and notice whether it is fresh or brackish; it is necessary to keep the top tube plate dry to find the leaky tube; otherwise, if the top glands leak, the salt water may run down a sound tube, because it is lower than the others. If salt water is running down a tube and the glands are tight it may be inferred that there is a leak in the tube. The practice in such a case is to drive a turned conical plug of soft white wood into both ends of the tube; the tube is identified at the top plate by passing a long wire through from the bottom. It generally happens that corrosion attacks a group of tubes, and, in some cases, 10 percent of the tubes may be so plugged before an opportunity occurs of replacing them by sound ones. Whenever a number of tubes have been corroded, it will be best to withdraw the whole for a thorough examination, and to test them under pressure singly.

If the salt water passes through the tubes, shut the main inlet and outlet valves tightly and rig the outside plugs on the ship's side (if possible) over the inlet and outlet orifices, then drain the condenser of fresh water and shut off all gage glasses and vacuum gages. Blank flange the pipes communicating with the low-pressure cylinder and air pump, and

also, if necessary, any drain pipes from the cylinders and from steam and exhaust pipes, which are led to the fresh-water side. Fill up the space around the tubes with salt water by a hose, inserted before the blank flange is put on the inlet for exhaust steam. A cock must be introduced in this blank flange, leading by a copper pipe to a test pump, by means of which a pressure not exceeding 30 pounds per square inch is put on the condenser; the interior of the condenser being under pressure, the tube plates are carefully dried and the ends of the tubes examined for salt-water leaks. The first proceeding should be to screw up all the slack glands. There is sometimes difficulty in detecting a leaky tube, because the water pressure being applied outside the tube tends to close up openings; whereas under working conditions the salt water is drawn through from the inside by the outside vacuum, and any rents or cracks are opened out. In such a case all the tubes may have to be withdrawn and subjected individually to a water pressure applied internally. The writer has experienced such a necessity, the condenser being proved to leak under steam, though when cold and subjected to a water pressure no leaks could be detected. It may also happen that the leak occurs not through the tubes, but under the bolt heads securing the stays between the tube plates. It is always advisable to withdraw the packing from the glands of a number of tubes, to ascertain whether it is perished. If a jet of steam is discharged on to the tubes from a drain pipe or through the eduction pipe, it may cause them to chafe, and the jet of steam itself may wear holes in the tubes so that leaks are caused. To prevent such action, baffle-plates should be fitted to distribute the steam delivered and to take the momentum of the impact; the tubes should be a close fit in the intermediate diaphragm plates in order to prevent chafing. The internal surfaces of a condenser that are exposed to sea water should be coated with a good wash of Portland cement at each examination. If the usual waste of fresh water is noticeably diminished in quantity, there is good reason to suspect a salt-water leak to the boilers, and the density of the feed water should be immediately taken. It is a good plan in doing this, to boil away three-fourths of the water drawn off from the hot well before taking the density, in order to magnify the effect of a slight leak of salt water, which might otherwise escape detection by the salinometer or hydrometer. The latter is so graded that the density of sea water is 10 at 200 degrees Fahrenheit. It is also very useful to remember in this connection that nitrate of silver, if added to water containing even a trace of salt, produces a cloudy white precipitate. Should the water drawn off from the hot well show a density as low as one-half by the hydrometer, or should it even taste slightly brackish, it is necessary to take steps to ascertain the cause of the salt-water leak. Such a leak resulting in a rise in density of the water in the boilers is generally occasioned by leaky condenser tubes, and this can only be ascertained by opening up the condenser as previously indicated. There are, however, other causes, some of which may be found and remedied whilst under way.

(1) The sea suction of one of the feed pumps (if they have a sea connection) may not be properly closed.

(2) The air pump may be fitted with an automatic spring-loaded discharge valve, delivering into the circulating water discharge pipe overboard; if this valve is leaky, or is prevented from closing, salt water will leak back to the air pump during a temporary stoppage of the main engine. This automatic valve is fitted to relieve the air pump of a glut of water on starting; also for the discharge of the salt water admitted to the condenser, when the jet injection is in use. Jet injectors were formerly fitted to surface condensers for use in the event of the circulating pump being disabled.

(3) If the evaporator primes when the vapor formed is being passed into the main condenser, the density of the water in the hot well will rise, since the density in the evaporator is high.

(4) The supplementary or extra salt-water feed cock may be leaky.

One of the most important duties of the engineer of the watch is to pay close attention to the vacuum gage, recording the amount of vacuum in the main condenser. A reduced vacuum is a fruitful source of loss of economy, and the cause should be investigated. The temperature of the feed water delivered from the air pumps should be from 90 to 125 degrees F., depending on the temperature of the sea water, and the speed of the circulating pump should be adjusted to produce this temperature, or the main injection set to obtain this result, as the case may be. If the feed water is too hot it is probable that there is not enough circulating water and the vacuum will suffer; if, on the other hand, the feed water is cool and the vacuum is bad, the fault is probably with the air-pump valves, or may be caused by an air leak into the condenser; it is then advisable to go round all drain valves on the condenser, air pump and exhaust steam pipes, and see that they are not open to the atmosphere; also, if the main circulating engine exhausts both to the main and auxiliary condenser, see that both exhaust valves are not open and inspect the suction leading from the feed pumps to the condenser if so fitted.

Try the silent blow-off valve and the soda cock, and make sure they are shut. An imperfect vacuum may also be due to leaky glands on the low-pressure cylinder, which need repacking, or a split in the low-pressure receiver pipe, which latter the writer experienced in a certain case. Examine the vacuum gage, which may be defective or partially shut off; there are generally more gages than one on which the vacuum may be read. If they all show a low reading the vacuum is most probably defective.

It may be interesting to cite a case in which the writer had an experience with a leaky condenser a good many years ago. The steamer which he joined as second engineer had been laid up idle for some eighteen months, previous to her being chartered for mail and passenger service to the East Indies. It will naturally occur to every engineer that there was a considerable amount of overhauling to be done to get her ready for sea. Among other things, the chief decided to clean out the condenser, which was very dirty, and we proceeded in the usual way and in the manner herein before described, closing all outlets and inlets, and running the condenser nearly full of fresh water mixed with a strong solution of soda. A ¾-inch copper pipe was coupled up to the donkey boiler steam pipe and the condenser was thoroughly boiled out, then washed, and afterwards tested under a low-water pressure, to make sure all the tubes were tight, and, so far as could be seen, everything seemed in good order and condition. It ought to be here stated that the circulating water passed through the tubes, which had their ends packed with soft white wood ferrules. Accordingly the condenser was closed up, and, the other repairs and overhauling being completed, the vessel put to sea on her sailing date. We had not been many hours on the voyage before it was found that the boilers were gaining water. The feed water was immediately tested and found to be rather brackish, and some density was shown by the hydrometer. After consultation with the captain, the chief decided to stop the ship and take off the condenser doors, to ascertain the extent of the trouble; this was soon done without much trouble, as the weather was fine and the sea calm. The top man-hole door was also removed and the condenser run up full of salt water with a hose, and when this was accomplished quite a number of small leaks at the ends of the tubes were located and marked. After all the tubes had been carefully scrutinized the water was allowed to run from the condenser and all the leaky tubes were re-ferruled until all the spare ferrules had been used; the rest

of the leaks were plugged. It was not, however, without some uneasiness that the doors were rejointed, as, judging from the condition of the old ferrules, there was trouble ahead; they were more or less perished, and the boiling they got, after the condenser being so long unused, pretty well finished them, although, as previously intimated, they appeared to be tight under test. The engines were put ahead again at a reduced speed, a close watch being kept on the feed water and the boiler water gage glasses, which, to our relief, did not show any increase in the water level. This state of things continued for about two days, when we ran into a heavy southwest gale in crossing the Bay of Biscay, accompanied by a mountainous sea, which caused heavy racing of the engines in spite of the efforts of the engineer standing at the throttle valve to ease her.

The outcome of this could be easily foreseen, as the circulating pump was worked from the levers on the low-pressure engine; the unequal revolutions of the engine sending the water through the tubes sometimes with a heavy thud, and then easing up, started the tubes which had not been referruled; and, again, we saw the water very rapidly gaining in the boilers until we were forced to blow down to prevent priming. Soon the steam began to fall, the vacuum was diminishing and the feed water was cold; there were no valves on the suction pipe of the feed pumps to enable us to adjust the amount of feed, and we soon found the air pump discharging water overboard that the feed pumps could not cope with, and add to this that the water in the bilges was steadily increasing until the wing flooring plates were up in the boiler room. It soon became necessary to blow about 12 inches out of four 13-foot diameter boilers every hour or so, and one of the engineers was detailed to do this particular work alone, and it kept him busy.

Of course, we could not attempt to effect any repair in such weather, even if we had had sufficient ferrules to do it with, as the steamer would have fallen off in the trough of the sea, and it was all that could be done to keep steam enough to maintain steerage way.

Fortunately for us, some thirty-six hours after the weather moderated the captain shaped his course for the nearest port, which proved to be Vigo. Eventually we limped into the harbor and dropped anchor. When the condenser was again opened up, it was seen that but few ferrules remained of the original ones, and a few of the tubes were completely out of the tube plate at one end. It is needless to say a thorough job was done this time; the whole of the tubes getting new ferrules and some new tubes replacing doubtful old ones. Again the test under pressure was applied and proved satisfactory. Steam was raised, and the vessel resumed and completed her voyage without further mishap. Perhaps of all the anxious and uncomfortable times the writer has put in at sea, not the least exciting was this episode of battling with a leaky condenser.

C.

Seattle, Wash.

The Twelfth International Congress of Navigation.

This congress will meet for about one week during 1912, in Philadelphia, Pa. The programme is an interesting one, trips are to be made to various places not only near the city, but as far a-field as Canada. Visiting members are to be especially looked after in these excursions. Brigadier-General C. W. Raymond, retired, 315 Fifth avenue, New York City, is chairman of the American section.

Broken Reversing Block.

On one of the regular voyages of the S. S. *E*—— from Philadelphia to New York, all went well until we were going into the dock in New York, when suddenly the reversing block on the low-pressure engine broke, the engine was standing, and on the order being rung up on the telegraph "full speed astern," away went the block. It was in all probability caused by water accumulating on the top of the piston of the balance cylinder, owing to the packing ring not being tight. There was also very little clearance on the top.

F. J. S. N.

The Vacuum Question.

Hartlepool Engine Works, Hartlepool.

Editor, International Marine Engineering:

I am much obliged for your letter of the 18th inst. and enclosed copy of International Marine Engineering, in which you give my paper, recently read before the Northeast Coast Institution of Engineers and Shipbuilders (page 55, issue of February, 1911).

I note that you have also a leader on the same subject (page 83). At the bottom of the second column you refer to the question of extra circulating water required in obtaining a high vacuum. Mr. Weir also took up this point in the discussion, and I have pleasure in enclosing a few pages of my reply, and from which you will see that the extra power required is very slight and practically negligible.

Yours faithfully,

Feb. 20, 1911. p. p. D. B. Morison.

EXTRACT FROM MR. D. B. MORISON'S REPLY TO THE DISCUSSION ON HIS PAPER.

Mr. W. Weir credits me with being aware that in order to maintain 28 inches vacuum in a condenser "you must pump almost twice the circulating water" than is required for 25 inches, and goes on to say that "he has taken the liberty of correcting the figures by adding to each the necessary expenditure for circulating water.

Let us analyse the 1,500 indicated horsepower cargo boat proposition (Table 2, p. 55, February issue), in which the circulating pump is driven by the main engines, and ascertain what the correction desired by Mr. Weir amounts to.

With an efficient condenser and sea water at 60 degrees F., a condenser vacuum of fully 28 inches can be obtained with an amount of circulating water equal to, say, forty times the feed, or about 1,400 gallons per minute.

Assuming an efficient condenser and a circulating pump of the reciprocating type working against 10 feet total head and driven by the main engines, the power required will be as follows:

$$\frac{1400 \times 10 \times 10}{33000} = 4.25 \text{ pump-horsepower}$$

and taking into account the mechanical efficiency, this corresponds to, say, 6 indicated horsepower.

If the quantity of circulating water is one-half or twenty times the steam condensed, then the power required for driving the pump will be even less than one-half. Therefore Mr. Weir's "twice as much" is at the most 4 horsepower out of 1,500 horsepower.

Dr. Weighton has proved that the gain in power in a triple engine by increasing the condenser vacuum from 25 inches to 28¼ inches, provided the engine is suitably designed, is as much as 5 percent, therefore the gain in power in the 1,500 horsepower engine for the 3¼ inches of vacuum is 75 horsepower, less 4 horsepower for the pump, or 71 horsepower net gain.

In referring to this question, Dr. Weighton says: "The amount of increased power absorbed in producing 28¼ inches of vacuum, as compared with 25 inches, is so small in the case of properly designed and proportioned engines in relation to the total power developed by the main engines that it will make scarcely any appreciable difference if it be neglected."

CAR FERRY—"ANN ARBOR NO. 5"

What will probably be the most eventful trip on the Great Lakes for the year 1911 started on Sunday, Jan. 1, 1911, at 9:30 A. M., when the Car Ferry *Ann Arbor No.* 5 left the yards of the Toledo Shipbuilding Company at Toledo, Ohio, for Manistique, Michigan, arriving January 11, 1911, at 10 P .M. and loading cars January 12, and leaving at 10 A. M. for Frankfort, Mich.

To reach her destination, the steamer passed through part of Lake Erie, the Detroit River, Lake St. Clair, St. Clair River, Lake Huron, the Straights of Mackinac and part of Lake Michigan. In the Detroit River, the St. Clair River and the Straits of Mackinac, ice from 18 inches to 24 inches thick was encountered and passed through without any difficulty.

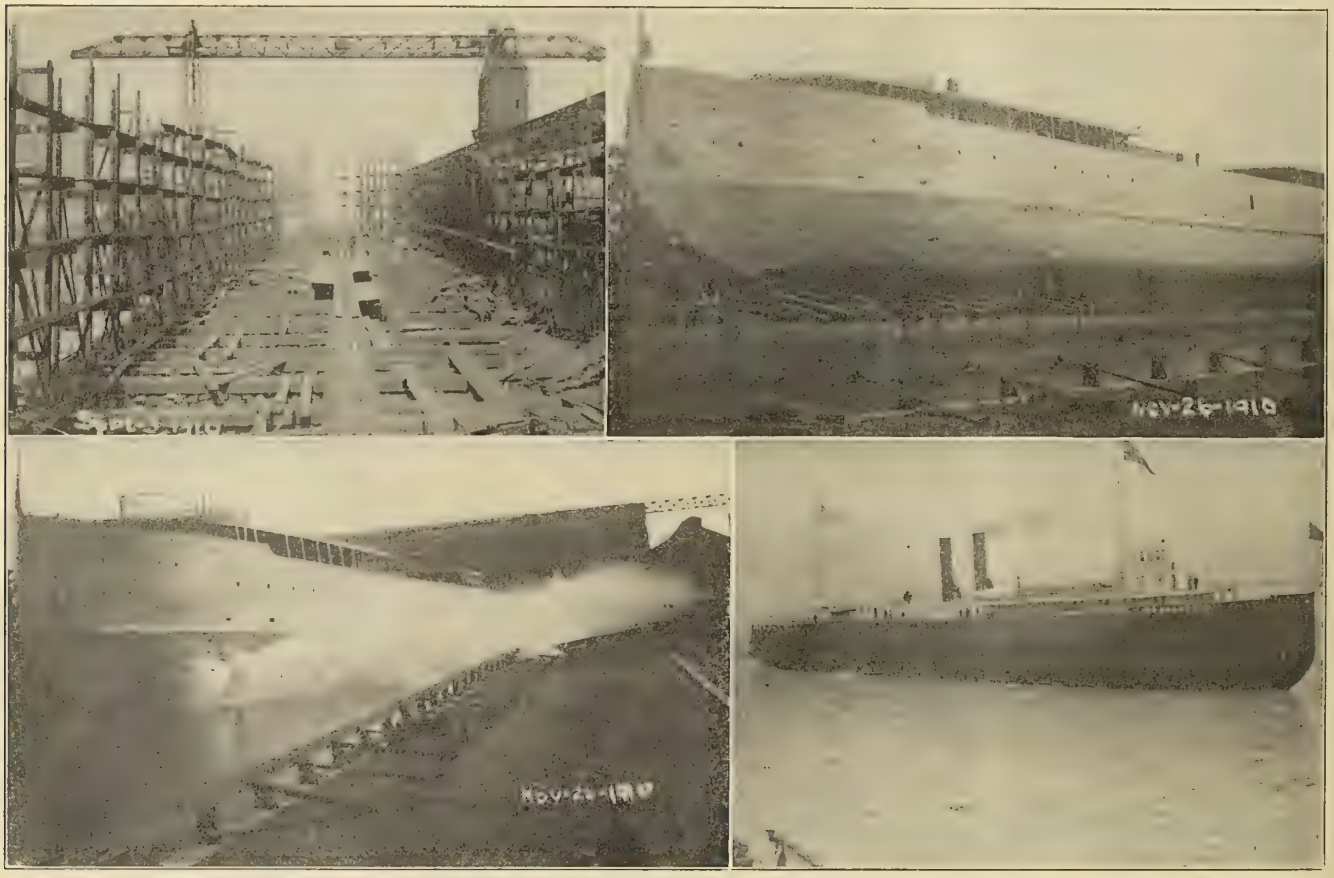
Opposite Marine City, on the St. Clair River, the steamer was for sixteen hours batling with ice 24 inches thick, very heavily windrowed; in most cases the windrows being grounded. Meeting the worst diffculties and conditions of the trip in the Straits of Mackinac, the steamer arrived at Manistique, a distance of 440 miles, in ten days and thirteen hours—under way during day-light hours only, thus establishing her reputation as an ice-crusher and a winter boat, arriving at Manistique without a mishap and everything in good working order and ready to take on a load of cars.

This car ferry is the largest of its type in the world, having a capacity of 30 42-foot cars, and is built for rigid winter service, running between the ports of Frankfort, Mich., and Manitowoc, Wis.

The contract was awarded by the Ann Arbor Railroad Company, from the design and specification of Frank. E. Kirby, to the Toledo Shipbuilding Company on July 1, 1911, to be delivered at Toledo, Ohio, on January 1, 1911, furnished complete. The keel was laid on September 3, 1910; the vessel was launched on November 26, 1910, and completed and accepted December 31, 1910.

The general dimensions of the *Ann Arbor No.* 5 are as follows:

Length perpendiculars	363 feet
Length over all	378 feet
Breadth moulded	56 feet
Depth moulded	21 feet
Height between car deck and shade deck	17 feet 4 inches
Height of funnels above top of casing	31 feet 6 inches



RAPID CONSTRUCTION OF CAR FERRY "ANN ARBOR NO. 5."

Height from keel to top of funnels	78 feet
Number of watertight bulkheads	7
Gross tonnage	2884
Net tonnage	1961

The scantlings of the vessel are heavy for the service required, some of which are enumerated below.

The stem, sternpost and rudder frame are of forged wrought iron. Stem 4½ inches by 10 inches, rebitted from the 6-foot water line to the main deck; sternpost 6 inches by 10 inches, and rudder 10 inches diameter stock, 5½ inches diameter pintle and extra strong frame.

The construction is of the transverse system, with 9-inch by 21.8 pound bulb-angle frames, spaced, 2 feet, extending alternately from bilge to main deck and bilge to shade deck, frames lapped on plate floors at bilge. Floors 30 inches deep at center of 20-pound plate on every frame of 3½ by 3½-inch by 11.1-pound angle frames and reverse frames; reverse frames doubled in machinery space.

Car deck beams of 12-inch by 30-pound channels, with 3½-inch by 3½-inch by 11.1-pound angles at top edge, spaced 4 feet, supported by three rows of heavy stanchions, brackets and ridge bars, car deck of 18-pound steel plate.

Keel plate 42 inches by 33.5 pounds, bottom plating 25.5 pounds, strakes shingled outside on the top edge and inside on the bottom, side plating 31 pounds, shingled. Main deck sheer strake, 31 pounds, doubled for two-thirds the length amidships. All shell plating forward from the keel to the sheer-strake doubled from the stem aft for 80 feet.

The steamer is built without double bottom, but each compartment is connected by a separate section and filling pipe through a manifold to a 12-inch by 20-inch by 16-inch ballast pump, so that any compartment may be partially filled or emptied for trimming purposes.

There are four tracks on the car deck, each rail set up on chairs of 8-inch by ¾-inch iron, located on each beam. Anchor rails outside of each rack, riveted to deck, to set up car jacks and holding chains. All the necessary car jacks, holding chains and gear were furnished as part of the equipment,

CAR FERRY "ANN ARBOR NO. 5," IN SERVICE IN WINTER.

together with a Westinghouse Air Compressor, piped to set up the air brakes on each string of cars.

The vessel is equipped with steam steering gear, electric light plant, steam windlass and capstan and steam gypsies.

A departure from the usual on this type of vessel is a hinged gate, enclosing the spron end of the ship for a height of 5 feet 6 inches above the car deck. This gate is for protection from the heavy following seas, and is operated by a winch, located under the car deck and is raised up out of the way when loading and unloading.

The cabins, consisting of smoking room, saloon, dining saloon, 15 state rooms and crew's quarters, are located on the shade deck. These are in pine and tastily finished in white enamel, all furnished complete.

The machinery and boilers are all below the car deck, with narrow casings extending up through to above the shade deck for stacks and light wells.

COAL BUNKERS.

Two coal bunkers of 500 tons capacity each, one forward and one aft of the boilers, extend across the ship with hatches between the rails of the tracks for fueling from hopper cars.

BOILERS.

Steam for the main propelling and auxiliary machinery is supplied by four single-ended cylindrical boilers, fitted with positive heated forced draft. The boilers are located in a single compartment, placed athwartships, with a fire room running fore and aft between them.

The boilers are 13 feet 6 inches diameter and 12 feet long, designed for a working pressure of 185 pounds. The total heating surface is 8,096 square feet, and the total grate surface is 184 square feet. The furnaces are 50 inches in diameter, with grate 5 feet 6 inches long, two to each boiler. Each furnace leads to a separate combustion chamber. The boiler tubes are 2½ inches in diameter and there are 334 in each boiler.

PROPELLING MACHINERY.

Propulsion is by means of two sectional propeller wheels, 12 feet 6 inches in diameter, with a cast iron hub and 4 cast steel blades to each. The propellers are each driven by a separate inverted, direct- acting, triple-expansion engine, having cylinders 21-inch, 33-inch and 52-inch by 40-inch stroke. Piston valves are fitted to the high and the intermediate-pressure cylinders and a double-ported slide valve to the low-pressure cylinder. The valves are actuated by the Stephenson double bar link motion, fitted with direct type of steam reversing gear. The pistons are cast steel. The piston rods, crossheads and connecting rods are forged steel. The crossheads have single slippers of brass. The engine framing consists of cast iron housings of box section, fitted on a cast iron bed plate made in one section. The crank shaft is of the builtup type. The thrust block is of the horse-shoe type. The air pump is of the ordinary bucket type, with jet condenser, driven together with a cooler and a bilge pump from the high-pressure crosshead.

The Institute of Metals, of Great Britain, has appointed a committee to investigate the subject of corrosion, and the first subject which will be taken up is that of condenser tubes. Sir Gerard Muntz, the president of the Institute, is naturally much interested in the subject, and G. D. Bengough, of the metallurgical department of Liverpool University, is in charge of the scientific work.

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Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

The bar before which all things mechanical must be tried and stand or fall by is commercialism. Opposition will avail but a short time if a money gain is shown. All history bears us out in this statement. Labor-saving machines or appliances can be translated as money-saving machines, and come they will, and to stay, for that very reason of saving, for they prove it. There is, however, much misrepresentation of facts. So often enthusiasm results in the fatal blunder of mistaking a success for victory that the world has learned to be very cautious in accepting statements from those directly interested. It is refreshing and rare to obtain such data as are given in this issue on oil fuel as applied to the revenue cutter *Golden Gate,* stationed on the Pacific Coast. The source of the information is such as to entirely preclude the possibility of error or sordid motives. That liquid fuel is being used in many places with great satisfaction is well known; but with the report referred to, in which it is so clearly shown how advantageous is its use, we look for a far more rapid advance in the future than in the past. There have been accidents reported with oil fuel, no doubt, but it does not need much brushing up of memory to recall accidents and dangers where coal has been responsible. It is unreasonable to anticipate that oil will become the universal fuel on shipboard, particularly in those parts of the world where coal is inexpensive and oil high in price; but the Pacific Coast of the United States is an ideal place for the use of oil, as evidenced by the figures quoted in the case of the *Golden Gate.* In very few places have engineers had the experience in using oil that those on the Coast have had, and this experience must, in a measure, account for this remarkable showing. Furthermore, there are few, if any, ports as conveniently suited for oil-burning vessels as San Francisco, as oil is piped to the wharves, and all that is necessary to do to fuel a vessel is to tie up to the wharf and connect up to the pipe line.

The fact that a number of eminent engineering establishments have taken up seriously building marine internal-combustion engines leads to the belief that there is faith back of works in this form of marine drive, if not wisdom. There are now several continental ships being fitted with this type of engine. Of three typical installations, one is a set of four-stroke cycle motor, single-acting cylinders of about 450 indicated horsepower; the second with a pair of two-stroke cycle motors, single-acting twin screws, each engine of about 900 indicated horsepower; and the third, a pair of two-stroke cycle motors, double-acting, of about the same power, and all of the Diesel type. It must also be remembered that in Germany there have already been built fishing boats equipped with these engines. On the larger vessels compressed air is used for reversing, while on the smaller boats a friction coupling and gear is employed. Of course, it is too soon to expect data as to the upkeep of large marine internal-combustion engines, but it will be the deciding point in their future use. It is probable that in the United States, where fuel is cheap and labor dear, repairs bear a larger relation to the fuel saving than in Europe, where these conditions are reversed. Or, in other words, what is saved in fuel may be offset by repairs. There are none, we think, to deny that the repairs of internal-combustion engines are far greater than those of steam engines, but just how much greater in large sizes of engines is unknown and is of grave importance. In discussing the subject of the upkeep of internal-combustion engines with those connected with their building and care it has been advanced that the cost of upkeep is not less than four times, or more than sixteen times, that of a steam engine—a wide margin indeed. There is no question whatever but that the upkeep is more. That improvements are on their way and will surely come is beyond question; but can the fact be overlooked or made light of that steam acts with a push while gas acts with a blow? And which of the two systems will result in the greatest repairs is hardly a question.

Test of Twin Screw Tunnel Boat A. M. Scott.

The board of engineers, appointed under Act of Congress to investigate the best type, and to design and build the best type of towboat and barges for navigation and transportation on non-tidal rivers, convened at Charleston, W. Va., in March, to examine, test and report on the twin screw tunnel steamer *A. M. Scott,* described in International Marine Engineering for November, 1910, and designed and built by the Charles Ward Engineering Works. The board required the boat to take a tow of six loaded coal barges over a very tortuous course, where the channel is first on the left side, then abruptly across the river to the right side, making an "S" or reverse curve to enter the channel and avoid the bar, thence to a narrow artificial channel made by wing dams and side walls, about 1/3 of a mile long, producing very swift water, difficult to enter and usually only accomplished by flanking until properly in line. Below is a narrow channel sharply curved its entire length, and very long, only navigable heretofore by continued flanking; thence through a shoal, hard to enter, through a lock to shoals, where the currents are troublesome, making 16 miles of hazardous navigation.

We are informed that the *Scott* took this tow over the entire course without ringing a single backing bell, except while waiting to enter the lock. The *Scott* returned later to Charleston, where she was very satisfactorily put through various maneuvers, loose, turning around by rudder power head-on in this narrow river, backing straight up stream, steering to port backward and reversing to starboard without stopping her engines, then manipulating her in similar manner by the engines alone. This is believed to be the first time a boat has steered a tow of six loaded barges through such hazardous places. Six loaded barges is the standard tow for the largest towboats taking coal out of this river in 7.3 feet of water.

TECHNICAL PUBLICATIONS.

Motion Study. Frank B. Gilbreth. Size, 5½ by 7½ inches. Pages, 110. Figures, 41. New York, 1910: D. Van Nostrand Company. Price, $2.

We think most people will rather smile at the general idea of Mr. Galbreth, until they take time to read with care his book. Usually the excuse will be lack of time, the very thing that the book proposes to save, and we believe that its perusal will repay many-fold those who are wise enough to know that they have yet to learn how to save time.

Industrial Plants. Charles Day. Size, 5 by 7½ inches. Pages, 294. Illustrations, 48. New York: The Engineering Magazine. Price, $3.

If we were about to build, or owned, an industrial plant, we would certainly buy Mr. Day's book. In looking about us we find most admirable door checks that are a saving on our nerves, yet all over the country we also notice that a brick or the end of a string is doing duty on doors, and we fear that, figuratively speaking, this is the case far too often in industrial undertakings. The study of Mr. Day's book should do much to correct this state of things.

Heat. J. Gordon Ogden, Ph. D. Size, 5 by 7 inches. Pages, 113. Illustrations, 46. Chicago: Popular Mechanics Company. Price, 25 cents.

We do not believe that anybody can possibly invest twenty-five cents to better advantage, unless he is starving, than by buying this book. The scientific information is most interestingly imparted, making the subject as attractive as a story and, while engineers are conversant with much of the text, all will enjoy and profit by reading it.

Applied Thermodynamics for Engineers. William D. Ennis, M. E. Size, 9½ by 6½ inches. Pages, 429. Illustrations, 313. New York: D. Van Nostrand Company. Price, $4.

As we are every day bending our energies toward economy, this book of Mr. Ennis will repay those who are deciding on what prime mover is to be bought, or recommended. Mr. Ennis does not claim originality, but certainly sets before the student with far more than usual clearness the very broad subject of applied thermodynamics.

COMMUNICATIONS.

A Very Interesting Inquiry.

Editor International Marine Engineering:

Being a reader of your valuable journal, I take the liberty of asking you for a bit of information concerning a change which I propose to make in the ballast of a steel hull.

It is 110 feet long, 35 feet beam and 10 feet deep; owing to the loads that are put on it, a lot of ballast is required.

The hull is rapidly decaying, although very good as yet. I propose to remove the present ballast, concrete the interior entirely; in other words, to produce concrete hull inside the steel one. I propose to thicken up the concrete where I need ballast. Do you think this idea is a practical one?

Montgomerey, Ala. Stein.

Editor's Note.—It will be interesting to know if any of our readers have ever had any experience which will shed light on the above expressed idea.

Editor International Marine Engineering:

Will you please let me know whether the heating surface of boiler tubes is figured from the exterior or interior diameter, and will you also give solution of the following problem?

The volume in feet per second for a 48-inch pipe 3,000 feet long with a head of 3 feet. The total volume of water to come through this pipe in twenty-four hours is 16,000,000 gallons. Pipe.

The heating surfaces of boiler tubes are figured on their exterior when the heat passes around them, and on their interior when the heat passes through them as in return-flue boilers.

To find the quantity of water in gallons when the diameter of pipe is known for a velocity of 100 feet per minute. Square the diameter in inches and multiply by 4.08.

PERSONAL.

Mr. Walter A. Post, who has been general manager of the Newport News Shipbuilding & Dry-Dock Company for the past twelve years or more, has been elected president of the company, to succeed the late Mr. C. B. Orcutt. This is a very fitting recognition of the splendid work Mr. Post has done in building up this great shipyard.

Mr. Robert Wallace, of Cleveland, Ohio, one of the pioneer shipbuilders on the Great Lakes, died last month, aged 76. He was one of the purchasers of the Globe Iron Works in 1869; later he expanded his shipbuilding interests, which afterwards became a constituent part of the American Shipbuilding Company.

Formal invitations have been issued in the name of Lord Brassey for the Institution of Naval Architects, 5 Adelphi Terrace, London, W. C., announcing that the Jubilee meetings of the Institution have been provisionally fixed for Tuesday, July 4, 1911, and the following days, when it is proposed to hold an international congress in naval architecture and marine engineering. The invitation has been extended to distinguished naval architects, shipbuilders and marine engineers in all parts of the world.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loat & Trust Building, Washington, D. C.

974,516. LIFE-SAVING ATTACHMENT FOR SUBMARINES. SNIVELY S. PETERSON, OF SAN FRANCISCO, CAL.

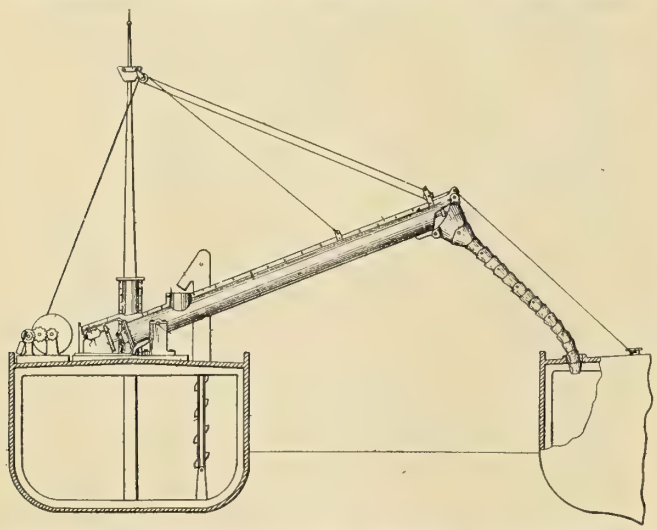
Claim 3.—The combination with a vessel adapted to be submerged, of a compartment in the vessel, and having ingress and egress door controlled openings, an edgewise swinging closure for the egress opening, means independent of said openings for admitting water into the compartment, and independent means controlled from within the compartment for draining the compartment. Eleven claims.

974,150. HYDRAULIC DREDGE. WILLIAM F. HUNTER, OF ARCATA, CAL., ASSIGNOR OF ONE-HALF TO THOMAS BAIR, OF ARCATA, CAL.

Claim 2.—The combination with a suction pipe having a cage on its inlet end, of a mouthpiece for said pipe having a portion partly covering the side of the cage to provide a side intake opening, and a gate carried by the mouthpiece for controlling said intake opening, the mouthpiece being rotatable and slidably mounted on the suction pipe. Eight claims.

975,312. COALING DEVICE. VAINO ANDERSON, OF KNAPPTON, WASH.

Claim 1.—In means for transferring coal from one vessel to another, the combination of an elevator comprising a tube pivotally mounted



upon the coaler and adapted to incline upwardly and outwardly therefrom, a flexible chute connected with the delivery end of the elevator and inclining outwardly and downwardly therefrom and connected with the vessel to be coaled, and a cable and pulley system between the two vessels and the said tube to automatically raise and lower the adjacent ends of the tube and chute to adapt them to the relative movements of the two vessels when riding the waves. Three claims.

975,534. METHOD AND APPARATUS FOR WRECKING BODIES SUNK IN WATER. ROBERT OWEN KING, OF BUFFALO, N. Y.

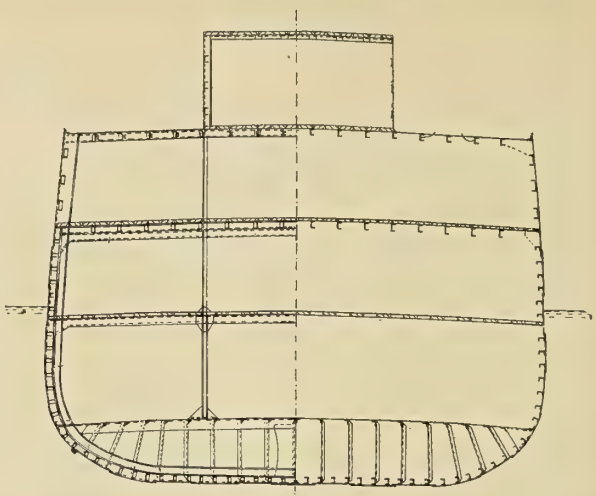
Claim 2.—An apparatus for wrecking bodies sunk in water, comprising a support, a drilling device mounted on said support, and electromagnets pivotally mounted on said support on opposite sides of the drilling device and adapted to attach themselves to said body. Four claims.

975,528. HATCH-FASTENER. ALEXANDER HYND, OF CLEVELAND, OHIO.

Claim 1.—In a hatch cover and tarpaulin clamping device, a bracket, a pair of independently movable clamping members, said bracket having a fulcrum support for one of said members and an inclined face or abutment for the other, and means one one of said clamping members and engaging the other for forcing one of the same downward onto the hatch cover and the other in engagement with said inclined face and hence latterly toward the coaming. Two claims.

975,699. SHIP OR VESSEL. CARL JOHAN FREDRIK MALCOLM LILLIEHÖÖK, OF STOCKHOLM, SWEDEN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO EMMA IDA BERTHOLDE CRAGGS, OF MIDDLESBROUGH, ENGLAND.

Claim 2.—A metal ship constructed with a plurality of continuous longitudinal beams directly attached to the deck plating, and a plurality



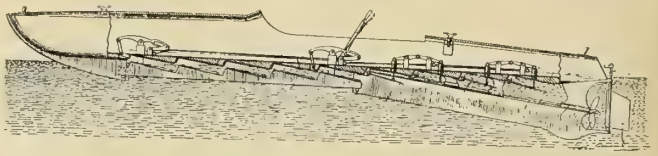
of cross beams disposed under the inner edges of the longitudinal deck beams; the upper longitudinal beams of the vessel being in preponderant number in relation to the cross beams. Three claims.

975,972. PROPELLER. GEORGGE B. MARTIN, OF MARIETTA, OHIO.

Claim 1.—The combination with a boat having a suitable suorce of power, of triple propellers carried by the stern of said boat and adapted to be operated by said source of power, each propeller comprising a housing adapted to be carried by the bottom of the boat, cam ribs carried by said housing, a sleeve journaled in the bottom of said boat, a revolable shaft extending through said sleeve and adapted to be revolved by said source of power in an opposite direction from said sleeve, propeller arms carried by said shaft and said sleeve, and pins carried by said arms and adapted to engage said ribs and rotate said arms in a desired direction. Four claims.

976,588. HYDROPLANE MOTOR-BOAT. CHARLES MELDAU, OF NEW YORK, N. Y.

Claim 2.—A motor-boat provided with a bow-keel increasing gradually in depth, a stern-keel also increasing gradually in depth, an intermediate



keel between the bow and stern keels, hydroplanes supported on said intermediate keel, and lever-mechanism for lowering or raising the intermediate keel and hydroplanes on the same. Eight claims.

977,438. AUTOMOBILE TORPEDO. GREGORY CALDWELL DAVISON, OF QUINCY, MASS.

Claim 1.—An automobile torpedo comprising a shell containing a chamber or flask for the storage of air or gas to develop the motive

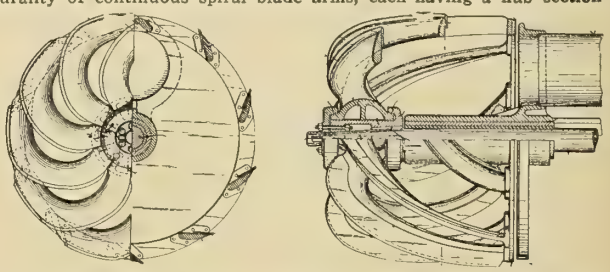
power, and machinery for driving the torpedo, and an explosive charge within the shell at the very stern thereof, whereby the gases resulting from the detonation are enabled to expand in the direction of the object attacked. Two claims.

977,815. PROPELLER. WILLIAM B. MAXWELL, GROVER C. MAXWELL AND EDWARD BUCKMAN, OF NEW YORK, N. Y.

Claim 1.—A propeller comprising a pair of blades having their circumferences disposed in the form of spirals from their leading edges to their following edges, the progressing face of one blade and the retreating face of the other merging into a continuous curve which extends from the eleading to the following edges, respectively, of said blades. Two claims.

977,901. CUTTER FOR HYDRAULIC DREDGES. ARTHUR W. ROBINSON, OF MONTREAL, QUEBEC, CANADA.

Claim 1.—In a cutter for hydraulic dredges, the combination of a plurality of continuous spiral blade arms, each having a hub section on

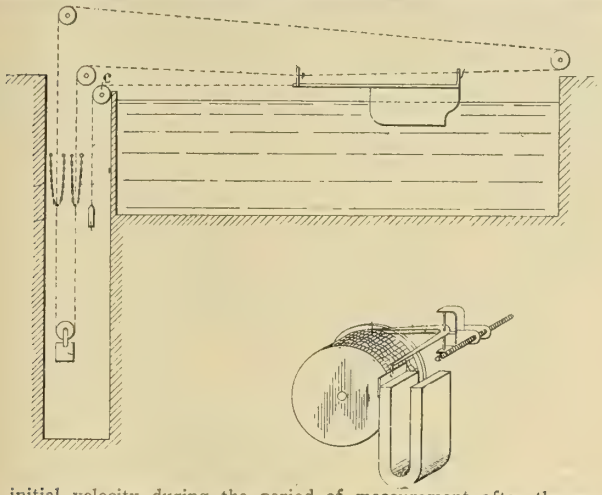


its inner end, and means for connecting said hub sections into a continuous hub. Eight claims.

978,090. SHIP-MODEL TESTING. HERMANN WELLENKAMP, OF KIEL, GERMANY.

Claim 1.—In tank testing appliances of the character described, means adapted to engage the model tested for imparting an initial velocity

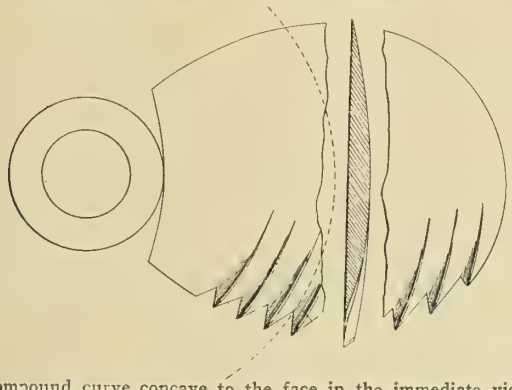
thereto, said means having limited duration of action a weight, and means in connection therewith for moving the model so as to maintain



its initial velocity during the period of measurement after the means for imparting initial velocity has ceased to act. Six claims.

978,677. SCREW-PROPELLER. DAVID WATSON TAYLOR, OF THE UNITED STATES NAVY.

Claim 9.—A propeller blade having in its developed section a substantially straight face extending to a sharp leading edge, and a back formed



by a compound curve concave to the face in the immediate vicinity of the leading edge and convex over the major portion of the bank, and ribs, concentric with the axis of rotation of the blade only on the leading portion of the back of the blade. Fifteen claims.

973,860. BARGE. RICHARD J. DONOVAN, OF AMBRIDGE, PA.

Claim 1.—A wooden barge having a steel rake end, consisting of side plating, bottom plating curved upwardly to form the rake, head or bumping block, a steel handling deck, and a steel water-tight bulkhead. Two claims.

972,809. LIFE-BOAT APPARATUS. AUGUST BRUN, OF CHICAGO, ILL.

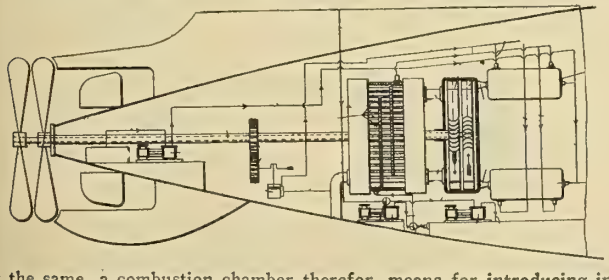
Claim 1.—In life-boat launching apparatus, the combination with a boat, of a supporting device which supports the keel and the sides of the boat and holds said boat in substantially horizontal position, an ejecting device which is movably mounted on said supporting device so as to engage one end of said body, and means for moving said ejecting device so as to force said boat lengthwise of said supporting device and eject the same therefrom. Twenty-one claims.

973,227. SUBMARINE BOAT EQUIPPED WITH SUBMERGING-PLANES. LAWRENCE Y. SPEAR, OF QUINCY, MASS., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—A submarine or submersible boat having submerging planes, in combination with mechanism for supporting the planes against the blows of waves on their under surfaces when they are out of water, said mechanism comprising a transversely extending structure lying closely above the planes so that it will receive the thrust of blows directed against their under surfaces. Seven claims.

931,546. UNDER-WATER VEHICLE. SEBASTIAN ZIANI DE FERRANTI, OF GRINDLEFORD BRIDGE, ENGLAND.

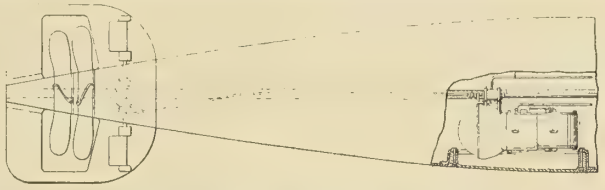
Claim 1.—In combination in a submersible, a combustion motor carried



by the same, a combustion chamber therefor, means for introducing into said chamber combustible and an excess of oxidizer, together with means for replacing said excess of oxidizer by a fluid other than said oxidizer under certain working conditions.

983,467. GYROSCOPIC STEERING APPARATUS. JOHN C. WALDRON, OF BROOKLYN, N. Y.

Claim 2.—The combination in a gyroscopic steering apparatus of a casing, an outer gimbal ring fulcrumed in said casing, an inner gimbal



ring fulcrumed in the said outer ring, a fly-wheel journaled in the inner ring, a steering engine connected to the casing, a valve chamber for the steering engine, an outer rotative cylindrical valve in the valve chamber of the engine, an inner tubular valve in the outer valve, connections between the said outer gimbal ring and the said inner tubular valve, and means to turn and locate the outer valve in operative position.

984,133. FLOATING DOCK. HANS GIESE, OF BERLIN, GERMANY.

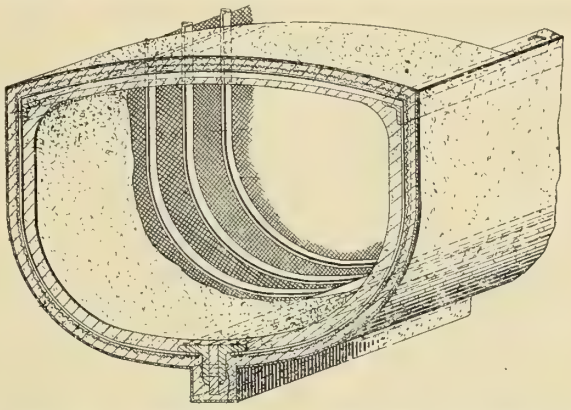
Claim 1.—A floating or off-shore dock, comprising a bottom pontoon having a chamber into which water passes while lowering the dock, and in which air is compressed by the entering water, a chamber to which water is admitted for sinking the dock, and means for forcing compressed air into said last-mentioned chamber to expel the water therefrom while water is being at the same time expelled from the first-mentioned chamber by the air compressed therein.

981,922. ELECTROLYTIC SHIP-CLEANER. GEORGE W. FRAZIER, OF PITTSBURG, PA.; MARY E. FRAZIER, ADMINISTRATRIX OF SAID GEORGE W. FRAZIER, DECEASED, ASSIGNOR TO PITTBURGH ELECTROLYTIC MFG. CO., A CORPORATION OF PENNSYLVANIA.

Claim 1.—In a ship-cleaner, the combination with a source of electricity, of a body movable independently of the ship to be cleaned, an electrode connected with and adapted to be supported in the water by the said body, and conductors leading from the source of electricity to the said body, one of the conductors being connected with the electrode, and another conductor arranged to be connected with the metal exterior of a ship.

984,285. HULL CONSTRUCTION. WILLIAM EDWARD McNEILLIE, JR., OF NEW ROCHELLE, N. Y.

Claim 2.—A hull construction, including a longitudinal beam, angle irons secured against the opposite sides of the beam and having their



out-turned flanges registering with the upper edge of the beam, a plurality of curved ribs secured in longitudinal spaced relation against the angle iron and extending upwardly therefrom, angle beams carried across the upper ends of the ribs and extending inwardly from the same, arched girders transversely disposed across the upper ends of the ribs and secured at their opposite ends upon the angle beams, a wire meshing secured against the outer faces of the ribs and the girders, and a body of concrete molded about the meshing to engage the ribs and the girders.

983,917. PROJULSION OF SHIPS. HENRY ALEXANDER MAVOR, OF GLASGOW, SCOTLAND.

Claim 1.—For the propulsion of a ship, the combination with a main thermo-mechanical plant of a supplementary alternating current electric plant capable of being used either alone or in conjunction with the main plant, at will, for driving the ship at different speeds and comprising an alternating current driving equipment capable of being run at different speeds.

984,152. WRECKING APPARATUS. FREDERICK OLIVER, OF CHARLOTTE, N. C.

Claim 1.—Apparatus for releasing grounded vessels, including manifolds, jet pipes suspended therefrom, means for supporting the manifolds in advance of the hull of a vessel, means for establishing communication between the manifolds, said manifolds and jet pipes being arranged to form a substantially triangular depression in the water-bed by the discharge of jets of fluid therefrom, flexible connections between the lower end of the jet pipes on each manifold, flexible connections between the jet pipes of the several manifolds, and forwardly and upwardly extending means for connecting the lower ends of the jet pipes to a supporting structure.

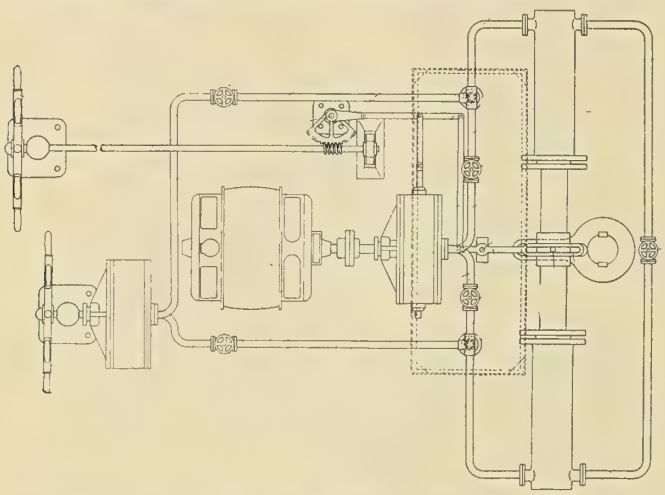
980,155. MARINE COMPASS. HARRY HERTZBERG, OF NEW YORK, N. Y., ASSIGNOR TO ABBOT A. LOW, OF HORSESHOE, N. Y.; MAURICE J. WOHL, OF NEW YORK, N. Y., AND HARRY HERTZBERG, OF BROOKLYN, N. Y., TRUSTEES.

Claim 1.—A compass comprising a box, a non-spillable liquid cup positioned therein, the side wall of said cup being curved inwardly upon itself and producing a mouth the diameter of which is less than that of said cup, a staff stepped in the cup and extending through the small diameter mouth portion thereof to a point above said cup, a magnetic needle mounted on the staff, and a float attached to the staff and adapted to be immersed in liquid to be contained in the cup.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

21,932. MARINE STEERING GEAR. F. L. MARTINEAU, LONDON.

This invention relates to the combination of a pump whose pistons have a variable stroke, a continuously running electric motor and a pair of hydraulic rams directly connected to the rudder head. The wheel



operates the stroke-varying rod through a worm and quadrant levers. The consequent travel of the rams operates through levers and links to return the rod and retain the rams in their new position until the wheel is again turned. An emergency pump worked by hand is provided, and stop valves as shown are provided for establishing the several water circuits.

22,320. AUTOMATIC APPARATUS FOR LIGHTHOUSES, ETC. F. G. ATTWOOD, LONDON.

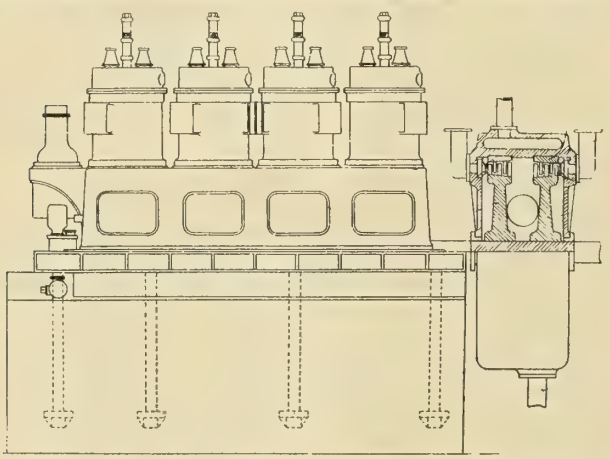
By this invention gas at constant pressure (from a reservoir through a reducing valve) enters an impulse chamber fitted with a diaphragm whose movements open and close through a system of levers, the gas supply inlet and burner outlet, alternately, to give intermittent or flash lights. The diaphargm also operates a ratchet and pawl mechanism for winding a clock which times the working of the apparatus, by turning a shaft once every twenty-four hours, to throw the apparatus out of and into gear at sunrise and sunset, respectively. The variation in time is corrected for by a worm connected with the operating cam, and which is caused by a star-wheel carried by the shaft to make one-seventh of a rotation each day. Another clock may rotate a lantern.

25,232. PROPELLERS. W. H. DOBSON, GRAVESEND.

Relates to paddles which revolve completely within the water. By this invention only the blades project beyond the skin of the ship, the drum which carries them having its axis at right angles and its water side flush with the plates. The blades are rotated, for feathering each upon its axis, by toothed gearing. Water is allowed to form a layer between the drum and its casing and any passing through is pumped overboard. The flow is entirely stopped when the propeller is inoperative by means of a conical ring, which can be moved axially to close the clearance space. It can be shown geometrically that the average angle at which these blades meet the water is greater than that of screw blades, while their Absolute speed is less.

8,186. STARTING AND REVERSING MARINE INTERNAL COMBUSTION ENGINES. DR. P. PRAETORIUS, STETTIN, GERMANY.

Diesel engines are by this invention provided with "ahead" and "astern" turbines, the motors of which are secured to the crankshaft



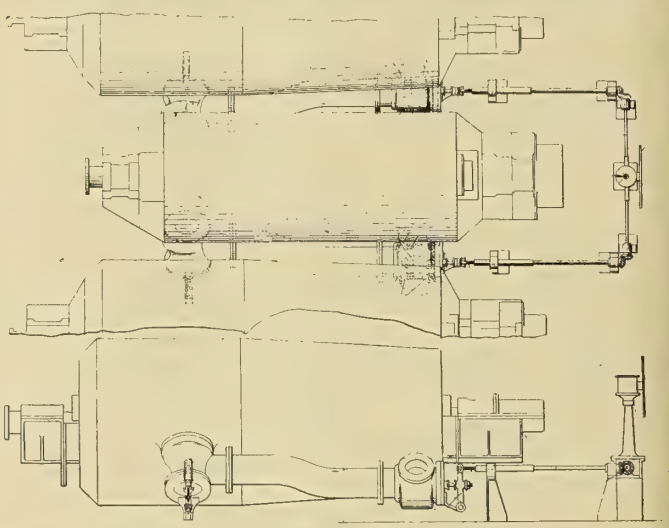
and operated by steam or compressed air. This method allows of maneuvering ships having these engines with great safety and facility. The radius of action of the turbines is increased by leading the exhaust from the main engine into the jacket and, when compressed air is used, the compression pump may exhaust air through a separate pipe with advantage.

25,734. ELECTRICAL PROPULSION OF SHIPS. SIEMENS BROS. DYNAMO WORKS, LTD., AND DR. KLOSS, LONDON.

A ship having four propellers is driven by means of asychronous induction motors and generators, two of the motors being driven at normal speed by generators, the frequency of which is fifty-two times the frequency of the generators which drive the remaining motors at normal speed. The frequencies of one or more of each set of generators having normal frequencies can be halved at constant-speed by interchanging the connections between generators and motors.

29,185. MANUFACTURING GEAR FOR TURBINES. J. N. BLENKINSOP, DOVER COURT.

According to this invention, gear is adapted to so control the supply of steam from the center turbine to the outer turbines that when steam



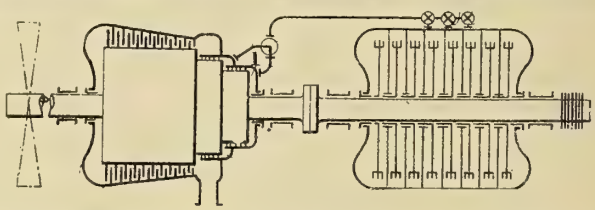
is cut off from either of the latter the other is receiving steam, thus enabling the center turbine and one outer turbine to go ahead while the other turbine may be either stopped or going astern. A hand wheel drives, through shaft and bevel wheels, a cross shaft geared to two side shafts, each having a female screw at its end nearest the valve and squared at its other end to engage and slide in the boss of the wheel that drives it. The female screws of the shafts screw into the two male adjusting screws of the valves. By rotation of the wheel in either direction one of the valves is closed by the end of the corresponding shaft bearing upon the valve actuating lever and the other valve is left free to work as usual.

16,160. SUBMARINES. G. PINO, GENOA.

The invention provides a device for saving the lives of persons who are imprisoned on a submarine which cannot be made to ascend in the water. In escaping, a person passes through the manhole j into the casing b, then he enters the buoyant chamber a through a door i, which he closes after him. He then opens cock k^1 and lets water through pipe k to fill the casing so that when screws f^2 are retracted the chamber a will rise from the vessel to the surface, where it will float with the cap h uppermost. l is a window.

28,943. MARINE TURBINE INSTALLATION. AKTIEN-GESELLSCHAFT. BROWN, BOVERI & CIE., BADEN.

This is a development of the invention No. 22,746, 1908, in which the propeller thrust of one turbine is counteracted by balancing devices in



another turbine. For maximum power chamber k is set in communication with chamber l, whilst for decreased power the valve o is turned and the pipes m and p are connected. Corresponding to the power, one of the stages of the turbine c is tapped and steam allowed to flow into the chamber k, and completely balances any axial thrust, even with the smallest loads. The valves are adjusted automatically when cruising.

29,895. SUBAQUEOUS AUDIBLE SIGNALLING APPARATUS. S. M. DAVISON, CAMBRIDGE, U. S. A.

This invention consists in securing to the skin of a vessel an enclosure in which is a shell free from the walls of the enclosure, and be-

tween the walls of the shell and the walls of the enclosure the air is withdrawn to form a vacuum which prevents sound passing to the inner chamber in which the receiving device is suspended. Another feature is the intensifying of the sounds passing, by insulating the receiver from the ship's noises, etc., so that only such vibrations as are received by the hull from without are transmitted, this insulation also largely absorbing vibrations caused by the engines, etc.